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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES' EQUIPMENT AND SUPPLIES ASSOCIATION.

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Forthcoming Events.

JANUARY 11.

Institution of Structural Engineers (Scottish Branch):—Ordinary meeting at Glasgow. "Structures with Welded Connections," Paper by C. Donald, B.Sc.

JANUARY 16.

Institute of Metals (Scottish Section):—Ordinary meeting. "Aluminium Bronze," Paper by F. Hudson.

JANUARY 18.

Institution of Welding Engineers (London Branch):—Ordinary meeting in London. "Welding in Civil Engineering," Paper by C. Helsby.

Institute of British Foundrymen.

JANUARY 7.

Lincolnshire Section:—Ordinary meeting at Lincoln. "The Application of Pulverised Fuel," Paper by W. Boon.

Lancashire Branch:—Ordinary meeting at Manchester. "The Effects of Phosphorus on Low Total-Carbon Cast Irons," Paper by W. West.

JANUARY 12.

Burnley Section:—Ordinary meeting at Burnley. "Scrap Castings: Common Faults in Common Practice," Paper by A. Jackson.

JANUARY 14.

Scottish Branch:—Ordinary meeting. "The Sand-Spun Pipe Plant of the Staveley Coal & Iron Company," Paper by J. B. Allan.

The Metallurgist, Founder and the Designer.

A little controversy has recently been taking place in metallurgical circles on the metallurgist, the founder and the designer—mainly on the non-ferrous side. The necessity for co-operation between the designer and the founder has been repeatedly stressed, and it was originally suggested that the metallurgist would eventually provide the connecting link between them. The development of methods of testing and micro-examination is doing much to educate the metallurgist in the properties of cast metals, and his training combines something of the knowledge of strength of materials and experience in materials, which is the special province of the designer, and something of the knowledge of the art of casting, which is the special province of the founder. There is, of course, much to be said for this point of view, and doubtless in many works the metallurgist does so function, whether he is fully conscious of it or not. Where the only scientifically-trained man available is, however, purely a chemist in the laboratory, this function is more difficult, if not impossible to discharge.

The point of view put forward above has been criticised by engineers on the ground that many metallurgists have little or no knowledge of the real engineering aspect of the designer's problems, and have less practical knowledge of foundry work than have many designers. Such critics regard it as practicable to secure that knowledge of metallurgy and foundry work which will enable them to know exactly when they should secure the assistance of an expert, such as the founder.

Perhaps a judicial consideration of the position would suggest that a great deal depends upon the man, and that in any given works the problem will solve itself largely according to the personalities of the people most concerned. This is recognised by wise managers, who believe in arranging responsibilities to suit men, rather than to compel men to fit arbitrarily defined spheres of responsibility, irrespective of whether they are suited to these or not. In some cases the metallurgist does make, and will make, an admirable link between the founder and the designer; in other cases he will not. Again, in other cases the link will not be necessary, and yet, again, in others, even if it were there it would not be fully utilised. We would, therefore, think it undesirable to come to a decision on a matter of this kind as a question of principle, because it is one best left to the circumstances of individual cases.

Those Obsolete Text-Books!

We learn that the American Foundrymen's Association is envisaging the publication in the near future of a pamphlet which will detail the real potentialities of castings. Whether it is to be confined to grey iron or extended to include non-ferrous we are not aware. The opinion of the American foundry industry is unanimous in that a continual and continuous injustice is being done to their industry by engineering works of reference which contain obsolete data as to the worth of cast iron and other cast products. The mere recital of tensile and perhaps transverse and compression strengths conveys a totally inadequate picture of the potentialities of cast iron as a material for application in engineering structures. It is not only the older text-books which fail to do justice to cast materials, for the very last one which we personally reviewed contained the following extraordinary statement: "Malleable sockets, ties, elbows and bends are used extensively for joining steel water and gas pipes. They are dipped in rosin to fill up the blow-holes." The title of this book is "Elementary Metallurgy for Engineers," and it is easy to visualise the impression likely to be made in the minds of the designers of the future by the publication of such a damning criticism of an important section of the foundry industry. We hope that the American effort will be crowned with success, and that all the arts and subtleties of modern publicity will be used to get the book into the hands of those responsible for the design of engineering structures. As a sub-title to the proposed publication, we would suggest: "Superseding all Text-Books." In passing it seems germane to remark that an authoritative British publication on analogous lines might be a real help in providing our engineers with a correct perspective of the newer high-grade castings now available to them in the home market. A New Year's resolution, worthy of the outlook of the modern designer, would be to make a bonfire of all the data on castings existing in obsolete and frivolous text-books.

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Correspondence.

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

Soda Ash.

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—The Paper read by the writer on December 1 last, and published in your issue of that date, was intended to follow up a somewhat more scientific account of a research on the subject, which appears in "The Foundry Trade Journal" for April 30, 1931 ("Desulphurising and Refining of Grey Cast Iron with Soda Ash," by Messrs. E. W. Colbeck and N. L. Evans). In that original Paper Mr. McConnachie will find several points dealt with concerning which he desires information, and which could not be repeated on December 1 owing to the limited time and space available. In particular, the effect of varying quantities of soda ash was dealt with.

The most suitable range of temperatures for the reaction was given during the discussion at the recent meeting. Between 1,200 deg. and 1,480 deg. C., the effect on grey iron is absolutely satisfactory, so far as sulphur reduction and structure refinement are concerned. Below that range the reaction is only limited by the decreasing fluidity of the iron (a variable factor), and above it by the increasing tendency of the reagent to volatilise.

Mr. McConnachie is surely quite wrong in attributing the increase in manganese content (in Table 1 of my Paper) to its concentration in a smaller weight of metal. The specific gravity of manganese sulphide is 4.0, as compared with 7.22 for cast iron. The manganese compound will therefore tend to float, and under normal conditions a proportion of it is always lost as slag. But when it is converted to metallic manganese by the action of soda ash, such loss does not occur.

The advantages of agitating molten cast iron to degasify it are now established beyond question. Whether the agitation is produced by passing a gas or by mechanical stirring is probably a matter of minor importance.

The use of soda ash for treating steel is not practicable. This point has been stressed by this company for nearly two years. At steel-melting temperatures the reaction is so violent as to be dangerous. The effect on the various constituents has reference to cast iron, as was clearly stated in my Paper. There is no definite temperature at which sodium carbonate either dissociates or vaporises unchanged. Both these processes take place to some extent at very low temperatures, but more rapidly as the temperature increases.—Yours, etc.,

N. L. EVANS.

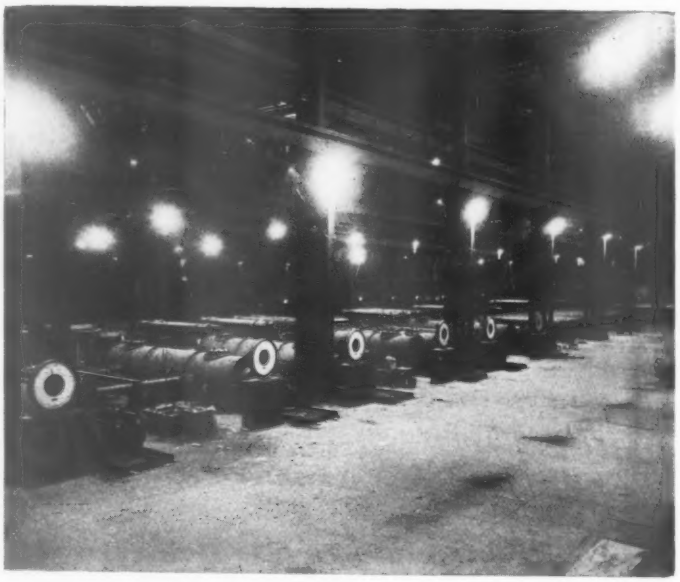
I.C.I. (Alkali), Limited,
Northwich, Cheshire.
December 28, 1932.

THE BLYTHSWOOD SHIPBUILDING COMPANY, LIMITED, Scotstoun, Glasgow, have obtained an order for a medium-sized twin-screw, bucket-hopper dredger. The vessel is ordered by an important English firm. The dredger is of a special nature and illustrates the versatility of the Blythswood Company, who within recent times have produced a wide variety of tonnage, oil tankers, passenger and cargo boats and other types of vessels. This is the first order to be placed in the Scotstoun area since July, when the same company received an order for a tanker. Messrs. Aitchison Blair, Limited, Clydebank, will supply the machinery for the present vessel.

Lighting a Pipe Foundry.

To facilitate production and to raise the standard of the processes involved, it is now deemed necessary in many parts of the country to improve the lighting of foundries. Hitherto much of the output of foundries has been undertaken under conditions of lighting which have impeded efficient workmen, impaired the quality of the work and often retarded output. With the growing appreciation of the service light gives in other directions, there has been inspired among foundry owners a keener sense of the value light offers in their own particular domain, and, as a consequence, numerous installations, based on modern principles, have been put in hand within the past few months.

The G.E.C. has been responsible for designing the schemes for lighting many foundries lately, and overcoming the problems involved where special applications of lighting have been considered necessary. A typical instance of the application of expert lighting technique, in collaboration with the actual installation contractors, is furnished in respect of the new Sand Spun Foundry of the Staveley Coal & Iron Company, Limited, near Sheffield. In this case the lighting is carried out by means of specially-designed overhead reflectors in conjunction with elliptical angle reflectors on the gantry supports. The main bay of this foundry is 420 ft. long by 150 ft. wide and 63 ft. high, so that a considerable area had to be covered by illumination calculated to give the most efficient results on an economical basis. That the scheme adopted has been successful is indicated by the photograph reproduced.



THE SAND SPUN PIPE FOUNDRY AT STAVELEY IS AMONGST THE BEST-LIT SHOPS IN GREAT BRITAIN.

In addition to the main building referred to, a number of subsidiary buildings have been illuminated, in accordance with the recommendations of G.E.C. illuminating engineers, to the complete satisfaction of all concerned. The whole of the lighting fittings, as well as the distribution boards and switchgear, the cable (Pirelli-General) and the lamps (Osram) for this particular installation were also supplied by this company.

THE PUBLIC EXAMINATION of Mr. R. S. Clayton, carrying on business at 7A, Pitt Street, Norwich, ironfounder, is to take place on January 10 at the Shire Hall, Norwich.

Random Shots.

Recently there has been something of a scare among Members of the Council of the Institute of British Foundrymen. It happened all through the Kaiser. After the war was over, and international debts became stabilised as "doubtful," the Kingdom known throughout the world as the Country of Gentlemen Who Always Pay Whether They Can or They Can't decided to pay something in gold on December 15 last. The London Branch of the Institute assured the success of its Annual Festival by holding it a few days earlier. The President (that is, of the Institute) was invited to attend the function, as usual, in full regalia. The Secretary, Mr. Makemson, took the Institute's lorry to the Bank of England and took out of deposit the Presidential Chain of Office. That Chain is, seriously speaking, extremely valuable. An exaggerated idea of its value has, however, spread in some directions—such in the Power of the Press—and, the day after, the New York papers bore the headline: "England Will Pay In Gold."

* * *

The tale has not, to "Marksman's" knowledge, been retold of how a student of the Sheffield University Metallurgical Department taught Prof. Arnold, the then distinguished Leader of that Department, a few parlour tricks. Terminal examinations included the complete analysing for five elements and the mechanical testing of a sample of steel, and a judgment from those data as to the process by which that steel had been made. The time taken to do the work was counted in assessing the marks.

To the amazement of all when the list of results was published some weeks later, a student who, though bright, was not generally considered brilliant, headed the list. It had been noted by his colleagues that he had finished at the exam. a good half-hour before anyone else for the written paper and half-a-day before anyone else in the laboratory work. Being a sport, he told the masters and students (but not till next term!) that when he had ascertained the carbon, manganese and phosphorus in his sample of steel he realised he had been given a piece of acid Bessemer steel; and the rest was easy guessing for a bright student.

And we are told by young students that life was easy in our day!

MARKSMAN.

High-Duty Cast Iron.

At a joint meeting of the East Midlands Branch of the Institute of British Foundrymen and the Derby Society of Engineers, held at the Technical College, Derby, on December 10, 1932, Dr. A. L. Norbury, of the British Cast Iron Research Association, gave an address on "High-Duty Cast Iron." Mr. C. W. Bigg presided.

DR. NORBURY said it was proposed to consider chiefly grey iron of high tensile strength and high resistance to shock, and to refer briefly to others having easy machinability and others having great hardness and resistance to wear. He called attention to the fact that it was rarely possible to consider only one mechanical property, an obvious example being that it was useless making a complicated casting of high tensile if it had such high shrinkage as to cause cracking during cooling. Also, it often happened that two of the chief mechanical properties were antagonistic, as, for instance, easy machinability and good resistance to wear in motor-cylinder castings. Tensile strength, he said, depended on composition, and also on the size and manner in which the constituents, especially graphite, were distributed.

Influence of Graphite.

Graphite, having little or no mechanical strength, was a source of weakness. Cast iron without graphite would be as strong as steel. Generally speaking, the smaller the graphite flakes, the stronger the iron. Dr. Norbury illustrated bars of ½-in., ¾-in., 1-in. and 3-in. diameter, showing the smaller graphite flakes on the smaller, more rapidly-cooled, bars. Tensile decreased as graphite increased. Another important fact was the uniformity of the graphite size. Two irons of identical analysis were illustrated, one having uniform graphite distribution and the other a mixture of coarse and fine-flaked graphite, showed a lowering of tensile strength from 23 tons per sq. in. to 14 tons. Another factor influencing tensile strength was the amount of graphite. Four irons of similar silicon, manganese and phosphorus content, but varying carbon showed differences in tensile strength from 20 tons in the lowest carbon to 13 tons in the highest.

Other Elements.

Of other elements in cast iron, manganese variations did not affect strength appreciably, since any increase in this element to give increased strength was offset by the higher silicon content necessary to keep the iron from being mottled. Phosphorus had a complicated effect. Its normal action was to lower strength, but up to about 0.5 per cent. it had little effect, as its action of reducing the graphite size offset its normal action of reducing strength.

In practice, the chief difficulty of producing high-strength iron was in obtaining low carbon content and uniform graphite. It was common to obtain low carbon by melting steel scrap, but difficulties of obtaining a uniform graphite with this procedure occurred. It had been found that superheating the melt refined the graphite, but if this were not carried to completion, mixed graphite structures resulted. It had also been found that a similar effect was produced by additions of steel. It was believed that the graphite flakes began to crystallise out on solidification, from solid graphite particles which were not dissolved during melting.

It was possible to obtain a very uniform graphite structure by starting with a very low silicon, and consequently graphite-free melt, and bringing up the silicon by adding a ferro-alloy. Dr. Norbury then dealt briefly with several of the patented irons of recent years, the special features of which were high strength or soundness, etc. Finally, he referred to the high-nickel austenitic irons. He displayed a sample of this iron, showing a good bend test that could compare with malleable cast iron. These irons, he said, could be readily malleablised by heating for about an hour at 900 deg. C.

DISCUSSION.

MR. T. SPIERS (Leicester) asked for information as to the machining qualities of these high-tensile irons, and whether, when Dr. Norbury referred to shrinkage in white-iron castings, did he mean general shrinkage or to drawing around the runners.

DR. NORBURY said that, generally speaking, hardness was high in high-tensile irons, and machinability decreased as tensile increased. The tendency to "draw" increased as tensile increased. The lower the carbon, the more the iron would "draw."

Germ Theory.

MR. H. PEMBERTON (Derby) said he could not agree with the author's statement that graphite floated in the molten metal as minute undissolved particles. He thought that all carbon was in solution in liquid metal, and had proved it by pouring the metal into water, which gave white iron; but, in general, the slower the cooling, the greater the size of the graphite flakes. He would like Dr. Norbury to explain how graphite was formed when adding ferro-silicon. Obviously, by adding steel to the charge, carbon was reduced, but he would like to know why one iron picked up 100 per cent. more carbon than another when using different cokes, all other factors being constant.

DR. NORBURY said it was correct that practically all graphite dissolved, but under the microscope it was seen that minute particles did not dissolve. It was a minute amount, probably only 0.1 per cent. of the graphite present. If the metal was heated sufficiently long, all graphite would dissolve, but in the cupola the time was insufficient.

MR. PEMBERTON asked whether the author had any proof of that statement.

DR. NORBURY replied that he had seen the particles under the microscope, after using the same method as Mr. Pemberton, that is, by pouring the metal into water.

MR. PEMBERTON said he had never seen graphite under those conditions, even at 2,000 diameters magnification.

DR. NORBURY, continuing, said that white iron could absorb up to 4.3 per cent. carbon, but 10 per cent. silicon pig only had 1.8 per cent. carbon. The silicon precipitated the carbon, so that when ferro-silicon was added to white iron, as it dissolved the liquid high silicon, it threw out the carbon as graphite. He had done that in the crucible. Regarding the pick-up of carbon, it was a question of the coke. Some cokes reacted more than others. The figures to which Mr. Pemberton referred were obtained when using an all-steel charge.

Controlling Carbon Pick-up.

MR. STEVENSON (Nottingham), referring to carbon "pick-up" in the cupola, asked whether the metal would have a greater carbon "pick-up" when using a 91 per cent. carbon coke than when operating with, say, an 88 per cent. carbon coke. Was the "pick-up" greater with hotter melting, and was there any definite relationship between high-tensile strength and porosity?

DR. NORBURY: If the coke had more carbon, one would tend to get a higher carbon content. At a meeting given in Birmingham in the previous week, Mr. Shepherd had said, in making cupola-melted black-heart malleable iron, that if the carbon was high, he reduced the coke charge and that rectified it. Very high-tensile irons were bad from the point of view of internal segregation where a thick section adjoined a thin one, but in a thick section such irons would not be porous in the centre.

Use of Refined Irons.

MR. H. KING (Nottingham) said, to get a reasonable tensile, foundrymen purchased a refined iron, either cupola or open-hearth melted. In the latter, was the carbon completely eliminated and then readjusted? Then there was the iron made in the Sesci type of furnace, which, to his mind, was a synthetic iron. It had been his practice to specify that irons should be made free from steel. He was not actually referring to irons of 20-ton tensile and upwards. He thought that engineers generally looked upon those as freaks. For the engineers' purposes a 16-ton tensile iron would give a good solid casting. The alternative to refined irons was to add steel to pig and remelt it. Dr. Norbury had shown it would pick up more carbon on the second melt, and he thought that method would give sound castings. With steel, it was true that, if one kept a low phosphorus, one obtained a better tensile. The tensile of direct-melted steel mix was not so good as remelted steel-mix pigs. If one worked to 3.0 per cent. T.C., one would get trouble with shrinkage. Was not 3.3 per cent. T.C. associated with low silicon content, favourable for the production of sound castings? Engineers would "rust up" a casting showing a slight defect, and low-carbon irons would not rust so readily. As to carbon "pick-up," his experience was that, if one used a really good coke, there was very little carbon danger, although the coke was rich in carbon. He melted at 1,500 deg. C., and he did not get any carbon "pick-up." What was the effect of high temperature in the cupola on the graphite? His experience was that it refined the iron, especially if one used pig-irons of fine graphite structure.

Breaking New Ground.

DR. NORBURY agreed that there were refined irons made in different manners. There was an opinion that all-mine irons were better than those refined with steel. Then the cylinder irons made in the blast furnace had a very high market value. One could get quite large differences in irons of the same composition, depending upon how they were made. If the metal was melted hot, one produced a finer graphite. Time, as well as temperature, had an important effect. For some irons, he agreed that in some cases it was better to operate with a higher carbon and lower silicon, but with the low-carbon, high-tensile irons there was the very interesting proposition that these castings in some cases were better than steel castings, especially where there was complicated design. For instance, in America, it had been found that high-tensile grey iron could supersede steel castings for some of the parts connected with the automobile industry. He agreed that the low silicon and higher carbon had better casting properties.

Practical Details.

MR. BUTTERS (Ilkeston) asked whether white-iron scrap could be utilised for grey-iron castings by mixing with ferro-silicon or high-silicon pig-iron, and what quantity would Dr. Norbury suggest?

DR. NORBURY replied that white-iron scrap could certainly be used up in that way, but he could not give proportions without knowing the nature of the white iron.

MR. T. SPIERS: How was the ferro-silicon to be added?

DR. NORBURY: Either in the cupola in briquette form or in the ladle in a finer form.

MR. SANDER (Derby) said he had heard that night of irons of over 20 tons tensile. Those irons had a limited field, and they were rather beyond the ordinary engineer's castings. Dr. Norbury had said phosphorus should be limited to 0.5 per cent. His experience was that it was

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easier to get high-tensile strength with the phosphorus controlled between 0.5 and 1.0 per cent. It was useless having high tensile unless one also had a metal of good impact resistance. The irons mentioned were of low T.C., and the problem was to get low T.C. in the cupola, and most people turned to steel additions. Steel appeared to have a physical as well as a chemical effect. Two irons, one with steel and one without, of similar analysis, would give different figures. Had Dr. Norbury any views upon a machine for ascertaining the wearing properties of cast iron? That was very important, as cast iron was used extensively for bearings. He would have liked to have seen some castings or photographs of actual castings made in the irons to which Dr. Norbury had referred.

DR. NORBURY said he was afraid he had not made clear his remark on the 0.5 per cent. phosphorus. Phosphorus really did give a decrease of strength, but as it had a fining effect on the graphite, it was offset, and the strength was increased in that way. As to wear testing, there were very many machines claimed to give that, but there were so many other considerations. A wear test, for instance, at room temperature, without lubrication, would not give reliable figures for the wear of a motor-cylinder block. In connection with the practical application of high-tensile irons, he would mention Diesel-engine liners, and various parts of motor-car engines.

MR. J. B. FENWICK (Derby), referring to Mr. Stevenson's query on carbon "pick-up" with high- or low-carbon coke, thought the former would give less "pick-up" owing to the quicker melting rate.

A vote of thanks to the lecturer concluded the meeting.

Notes from I.B.F. Branches.

Lancashire Junior Section.—The monthly meeting of the Junior Section, Lancashire Branch, Institute of British Foundrymen, was held on December 17 in Velvet Buildings, adjoining the Manchester College of Technology. Mr. R. A. Jones was in the chair, and MR. E. L. RHEAD, M.Sc., gave a lecture upon "The Conditions Affecting the Behaviour of Carbon in Cast Iron."

The visit of Mr. Rhead to the Junior Section had been eagerly anticipated by the members, who were present in good numbers.

Mr. Rhead's Paper was well illustrated with lantern slides and many fine specimens of fractures, etc. He stressed the importance of carbon as being the most important element and the keynote of the behaviour of the iron, as elements added affected the carbon and not the other elements.

He summarised the general effects of carbon as follows: (1) That carbon may remain permanently alloyed with the metal; (2) that carbon may remain completely separated; (3) that carbon forms chemical compounds, and (4) that carbon may remain partly in solution and partly as an element.

He especially stressed the point that when the iron is molten, all the carbon is in the form of carbide, provided the temperature is sufficiently high.

The germ theory was referred to and also the effect of elements reducing the stability of the carbides. The effect of temperature, the solubility of the carbon, the rate of cooling and the composition, were reviewed, and the many causes and effects examined.

Some notes on malleable iron, both black-heart and white-heart, showing again the difference in the carbon composition and treatment, concluded a very interesting lecture.

A hearty vote of thanks was proposed by MR. E. COOKE and seconded by MR. D. MENZIES, and an animated discussion followed in which many participated.

Copper Curtailment Problem.

BY "ONLOOKER."

The breakdown of the copper producers' conference on curtailment of output during 1933 came as a surprise to the market, for in most quarters it was considered that, in spite of all the threats and beating of drums by interested parties, an agreement would be reached in the manner beloved by the copper people at the eleventh hour, when hope had almost been abandoned. Difficulties and differences of opinion were known to exist in plenty, but desperate diseases require desperate remedies, and the copper situation is certainly parlous enough to persuade the most pig-headed.

Quite apart from the price, which stands but little above the lowest ever recorded in the history of the metal, world consumption is at a tragically low level, and it is not at all certain that the rate of use is not still declining. Much leeway has to be made up, for during the period of abnormally high prices, and, indeed, throughout a number of years, when the price of copper has been among the most unstable of all the commodities, the metal has fallen into disfavour and has been supplanted by rival metals and synthetic products which are growing in popularity almost daily on account of their durability, lightness and resistance to corrosion. Unfortunately for the red metal, there is something of a slump in the electrical industries, and at a time when the exceptionally low price ought to encourage its wide use, capital is not apparently available to finance such enterprises. On the consumption side, therefore, the outlook for copper is far from rosy, and, although there has been talk of concerted action to popularise its use, the portents for increased employment of this important metal are not particularly favourable.

Stocks of electrolytic qualities are enormous, and there is probably enough of this grade above ground to-day to keep the world going for well over a year. A six-months' shut-down by the American mines was, as a matter of fact, mooted, but the proposition is so hedged about with difficulties that it is almost certain to prove abortive. Owing to quiet times in the electrical and allied industries and something of a slump in the making of munitions, electro-copper is not a great deal in demand outside the United States, where it still constitutes the bulk of the tonnage used. Of fire-refined and Bessemer copper, the reserves are certainly not overwhelming, and, indeed, in the latter quality there is something of a shortage. To that extent the adverse statistical position in copper is somewhat one-sided.

The question which the producers in council had to settle was in essence a very simple one, viz., whether or not they should continue throughout 1933 to curtail down to 20 per cent. of capacity and in what way the quotas should be distributed. For the final breakdown of the talks the Roan Antelope Company, one of the low-cost Rhodesian producers, was blamed by the American interests, but in a spirited defence of their claim for an increase (quite a modest one it would appear) in the quota allotted to them this company rebutted the attacks made and proved to the satisfaction of right-thinking people that the claim put forward was just and reasonable. A detailed statement of all that took place at the recent conference is not likely ever to become available, but judging impartially on such facts has have come to light it does seem that America, having shut out foreign producers by means of a 4 cent duty, still wishes to compete on equal terms in European markets. It is the old story of "wanting to eat the cake and have it" which has wrecked so many conferences, both commercial and international, and on this occasion the rôle of greedy boy would appear to be played by the American copper interests.

There is now talk of some arrangement being concluded among the United States producers themselves, but definite information is lacking, and in any case a final decision is likely to rest with those banks who are financing the enormous stocks of copper and are thus the parties most interested in the affairs of the red metal at the present time. Within the confines of the United States a continuance at the rate of 20 per cent. of capacity is certainly imperative, and it would really be advisable, if stocks are to be drawn upon, that something more drastic, say a further cut to 15 per cent., should be instituted forthwith. As already stated, definite information is lacking, but it does appear likely that drastic action will be forced upon the American copper-mining interests.

As to those mines outside the United States it is already evident that some of them mean to take advantage of their freedom from restraint in 1933 to speed up production to some extent. Chile, a low-cost producer, is more than likely to put more fire-refined and bessemer copper on the market, for, as already mentioned, there is certainly no glut of these qualities. At least one important property in Canada is making money even at the present distress levels of price, and should the need arise there will be no hesitation in going out to meet it by increasing output. Rhodesia's policy has recently been fully dealt with by those directing the affairs of copper-producing companies in that country, and in this connection, as also with Canada, the copper duty agreed at Ottawa must not be overlooked. The Katanga Company is said to hold considerable stocks of electrolytic, but since they supported continuance during 1933 at 20 per cent. of capacity it is doubtful whether much increase of output is contemplated in that quarter.

That some increase in production is going to take place seems fairly certain, but both on the score of present price and in the interests of preventing a further decline in values this is certainly not likely to be excessive. On the other hand, many high-cost properties must now be finding the strain of producing at a loss almost intolerable, and it is questionable whether they can resist the march of economic events much longer. The plain truth is that the high-cost copper mines are temporarily doomed and they may as well realise that unpalatable truth first as last. The market has long been awaiting definite news that these relics of a comparatively recent but nevertheless bygone era have decided to abandon the unequal struggle, and when the announcement *does* come the real recovery in copper values will begin.

Belfast Firm's Progress.

Despite the difficult trading conditions during 1932, Messrs. Davidson & Company, Limited, Sirocco Engineering Works, Belfast, report a fairly busy year, both in so far as actual activity in the shops is concerned and also from the aspect of development work in their various lines of manufacture. In power-house work the problems presented by modern systems of powdered-fuel firing involving higher air pressures and gas velocities have resulted in considerable research and experimentation having been devoted to new designs of mechanical-draft equipment and dust-collecting plant, to meet these altered conditions and to secure still higher operating efficiencies. The year has witnessed the practical completion by the firm of the Dunston Power Station contract, the largest ever placed for mechanical-draft plant, including dust-collecting equipment, while other important contracts for similar installations elsewhere have also been undertaken. Considerable development work on pneumatic conveying plant for the local transportation of ashes, riddlings and flue dust in steam-raising installations, etc., has been effected. Some notable contracts were also secured in connection with heating, ventilating, steam removal, air conditioning and similar installations. Early in the year the firm acquired the fan patents and trade-mark rights of Aeroto, Limited, formerly manufacturers of the "Aeroto" patent screw fan.

Further Notes on Oil-Engine Foundry Practice.

By Herbert E. Beardshaw, A.R.T.C. (Salford).

(*Concluded from page* 403, *vol.* 47.)

Running of Castings.

The function of the runners and runner bush is to provide a means of introducing the metal to the mould as efficiently as possible. What is the use of obtaining the metal in an ideal condition in the ladle—hot, clean, etc.—if the bulk of its characteristics is to be altered in a varying manner in the actual introduction to the mould? Some runners are made to alter the characteristics in a controlled manner.

Speed of running is controlled mainly by the smallest area of the in-gates and runner and the head of metal, and the author would like to correct an impression prevalent amongst some founders that the area of the reservoir of metal has not the slightest direct effect on the running speed. All other things being equal, a bush a foot square is as efficient as one a yard square. It is the depth that affects the speed of running.

For a small flywheel the desired features are denseness of grain, because it is in many cases a clutch casing, good balance, and capacity to carry a high stress.* It has been decided that the most suitable material is one of the following composition: T.C., 3.0 to 3.2 per cent.; Si, 0.8 to 1.0; Mn, 0.8; S, 0.06, and P, 0.2 per cent. or less.

This material has not much "life," its freezing range being very short. One would imagine that the best treatment would be large runners and introduce it as rapidly as possible, yet the result of such treatment is invariably unbalanced wheels due to contraction voids, draws and the like. The correct treatment is to determine the absolute minimum to which the size of runner can be taken successfully to cast the job, and work just inside that figure. This limit obviously varies for materials, temperature and weight, but, should the original control be good, the first two can be relied upon within reasonable limits and the only variable is the weight of the job.

The author is at present collecting data to substantiate the above and has arrived at a stage indicated by Fig. 1, from which he can

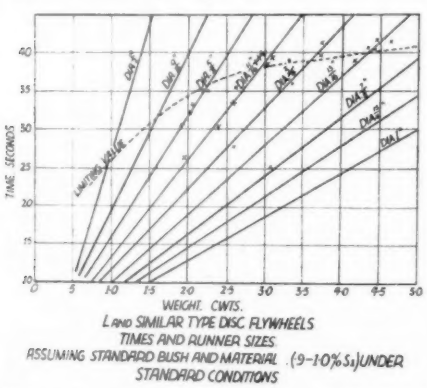
TIME SECONDS
WEIGHT. CWTS.
L AND SIMILAR TYPE DISC FLYWHEELS
TIMES AND RUNNER SIZES
ASSUMING STANDARD BUSH AND MATERIAL (9-10% Si) UNDER
STANDARD CONDITIONS

FIG. 1.—GRAPH, SHOWING RELATIONSHIP BETWEEN WEIGHT, RUNNER-SIZE AND TIME.

select suitable runners for any weight of small flywheel, and state the time in which it should be cast, and by attention to the other points affecting the result can invariably obtain a wheel of reasonable balance, *i.e.*, not more than 2 ozs. out when machined. The average flow on these jobs has been determined to be 10 to 12 lbs. per sq. in. of runner per sec. under standard conditions of temperature, material and head of runner. It will thus be seen that apart from small adjustments a wheel 3 cwts., with two ¾-in. runners, should be cast in 34 sec.

It will also be realised that it is very easy to overstep the mark. A ladle kept waiting or the temperature of the metal slightly low, and the 34th second arrives without the wheel being "cast." Perhaps it runs to 40; then the probability is that it is "short run," or perhaps it ceases to take metal after 25 secs., indicating that the runners are solid; then, again, it is only "half a wheel." Such things have occurred even when controlled, but in the early stages. This is an example of slow running, and the opposite occurs when considering cylinder heads, some of those for oil engines are very complicated castings containing cores and chills. They must be run rapidly, but everything is of such thin section that it must also be introduced very gently.

Down-Gates and In-Gates.

For the very latest design which represent an advance on the type quoted in the last notes on this subject, the runners are such that they enable the casting of this job to be accomplished in 6½ secs. Eight seconds would probably mean trapped gas and 5 secs. would mean that the chaplets had melted too early and some part of the core lifted. Here are the limits adhered to daily. Another point to be controlled in the designing of the runners is that concerning the relative areas of the in-gates and down runners. Should the area of the down-gate be less than that of the in-gates, the restriction is always in the down-gate, and the in-gates are not running full and are not all being utilised to fill the mould. The restriction should be at the in-gates; all should be running full, and, provided this condition is obtained, the size of the down-gate does not affect the case. It must be of sufficient area to pass sufficient metal completely to fill all in-gates.

This applies to all types of castings; the in-gates should be the limiting area, particularly so when dealing with an iron with short freezing range, for, imagining a case with the down-gate the restricting area, the in-gates are dribbling the metal through and defeating their original object.

With regard to such accessories as chaplets, the standardisation of such is essential. The difference in two deliveries of chaplets must be confined to narrow limits. A slightly heavier chaplet may mean that the metal does not seal that particular part and a leak results on water test, or a slightly lighter type means cores lifting, etc. A valuable index to the state of this cylinder casting is provided by the whistlers arranged along the crankcase face, metal dull, or other conditions affecting in a similar manner means that the whistlers do not run out, and exceedingly hot metal means that they do not seal up—the latter condition being ideal—the whistlers being so small that it is almost impossible.

With regard to the larger liners, again a low-silicon iron casting, the flow per sq. in. is only slightly higher at 0.12-0.13 cwt. per sec. per sq. in. but the runners have a greater area and the casting is much more rapid.

When the runners on this class were being adjusted several experimental readings were taken on castings that were very good examples. The rate of filling the mould was determined, a list of all other sizes (some had not been made) was drawn up and the runner sizes and times calculated. So far the actual results are exceedingly good, as all forecasts are correct within narrow limits. There is neither guessing nor trying, as recorded information is adjusted to suit altered cases.

Runner Bushes.

With the present trend being towards smaller machining allowances, and in an attempt to improve the standard of the castings, every founder realises that it is essential to prevent the entry of any foreign matter to the mould.

All bushes should be of a "non-swirl" type, and it is easy to make this possible by introducing some obstruction to any swirl. An increase of an inch or two in the depth of the bush will sometimes effect a cure.

When using low-silicon, and/or low-carbon irons the method of running from the bottom is hazardous. Once metal is in position in a mould it should be permitted to remain stationary. With bottom running, during the comparatively slow progress up the wall of the mould the outer skin becomes practically solid and invariably includes gas, sand or other foreign matter to the detriment of the casting. Such faults are doubly bad, inasmuch as they are not revealed until the casting is removed from the foundry. It is better to run at the top with as many small runners as is compatible with the conditions to have a non-swirl bush, and, if possible to eliminate stoppers. The numbers of small runners is advocated from the point of view of distributing the thermal and physical stock of the metal's entry into the mould.

Chills.

Chilling is called a necessary evil, because it is rightly regarded as an evil, but is resorted to in the absence of any better means of attaining the same object. The object is usually to densen a particular part of a casting, *i.e.*, accelerate the cooling of that part and so prevent several undesired features, such as large graphite crystals, the formation of a reservoir of molten metal to feed the adjacent parts and result in a draw. It is an evil in the opinion of many because of its uncertainty, *i.e.*, it is not susceptible to rigid control, but when carried out from day to day in a logical manner densening can prove very valuable.

Chills obviously require designing, as they are not just pieces of flat scrap picked up from the scrap dump. The surface area in contact with the metal, the volume of the densener, the venting, etc., all are the subjects for careful research in each individual case, as is also the coating to be used.

Certain cores embodying denseners have proved very valuable—in fact, it is the only manner in which some jobs were made possible. Again, where holes have to be drilled through thick bosses, an ordinary core does not always effectively close the grain and the metal may not be watertight, but the insertion of a metallic core will densen the material to a marked degree. Throughout, however, cleanliness is again essential, and any metal used as chills or denseners must be clean.

Drying of Moulds.

This feature of the industry has assumed very serious proportions, for when very ample machining allowances were made and more fluid irons were used, a scab, or blown part of a casting due to inefficient drying, had a fair chance of machining out, but with machining allowances cut to a minimum this is now impossible and risks due to bad drying cannot be taken. Furthermore, it is essential when using low-silicon irons to dry efficiently all runners and runner bushes. To the author's mind there is only one way to accomplish effective drying, and that is to dry at 200 deg. C. and make certain that the evaporated moisture is carried away.

It is doubtful whether a mould requires drying thoroughly or whether it should only be dried for a short distance away from the face,

* Other details were given in a previous Paper which appeared in FOUNDRY TRADE JOURNAL, June 23, 1932, page 385, vol. 47.

but one thing is certain: it should not be dried in such a manner that the face is "burned rotten," as have been hundreds of moulds seen by the author in various foundries. The fire bucket is still popular, but if only it could be realised how risky it is to dry in this manner they would be scrapped. There is a very large field for research in this direction. It is insufficient to dry it thoroughly—that can be done in such a manner as to cause wasters every time; the point is, when to stop with the drying operation in order to have the surface of the mould retaining the maximum desirable properties.

The author has found that in some cases a range of 20 deg. C. has made a vast difference to the mould surface. In one case the face resisted the abrasive action of the flow and in the other it collapsed at an early stage and permitted the metal to wash at the sand of the mould. When a mould is scabbed it is not only the immediate locality of the scab that worries; it is always a question of "what" has been washed into "where." In this connection it is to be regretted that concrete suggestions as to improvement cannot be made, as research into this phase is proceeding and definite conclusions have not yet been drawn.

The majority of the moulds for this type of work are dry-sand; in fact, it may be generally stated that they are all dry-sand. Here, again, methods of manufacture have already been described, but a note as to the state of the moulds immediately prior to casting would be in order. The whole mould and runners must be dry and warm; stoppers are not used on most of the jobs, but where they are used, they also must be dried. The percentage of wasters very definitely increases with the humidity of atmosphere if the conditions are not very carefully controlled.

Assume a very humid day, and one-hour's difference in the period elapsing between the closing of the mould and the casting means a much higher percentage of scrap, due in the main to gas holes in the parts of the casting above, say, any denseness. It needs very little atmospheric condensation to run a casting when one considers that 1 c.c. of water converted to steam at 100 deg. C. results in 1,400 c.c. of steam. It may be difficult to imagine, but when the resultant casting must not show even a pinhole in the bore, or other machined face, very little variation in any condition causes rejects, and it requires considerable observation, and in addition much exercise of ordinary technical common sense, to standardise or equalise these and any other variations that occur.

In order to suggest another phase of scientific control of the manufacture of castings, the author suggests, as on other occasions, the examination of problems from a simple hydraulic point of view.

The comparison between molten iron and other bodies usually known as fluids cannot be extended to all its properties, but for the present purpose to consider iron in a molten state as comparable to other fluids is, in the author's opinion, logical.

The probable reason that it is not generally considered is without doubt due to the difficulties of making the observations usually made with fluids, namely, specific gravity, and the like. But comparative observations can be made by using another molten metal that does not cause the same discomfort when handled, namely, mercury. It is a molten metal, the only difference being that its solidifying point happens to fall considerably below that of atmospheric temperatures. In this manner an approach to practical conditions can be made experimentally and the usual data obtained with regard to the flow of molten metals through small orifices.

Consider, for instance, the casting of the small disc flywheels mentioned previously. The weight of this wheel is 3 cwts. 1 qr. 6 lbs., and is to be cast in accordance with the generally accepted ideas on the subject, *i.e.*, slow running and self-feeding. The header of metal will be of the form shown in Fig. 2.

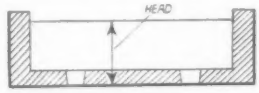

FIG. 2.—FORM OF RUNNER-BASIN USED.

Calculating Teeming Speeds.

The velocity with which the metal leaves the orifice will be of the following order:

Vel. (ft./sec.) = $\sqrt{2gH}$ where H is the head in feet. (This is assuming a behaviour similar to that of water.)

Knowing the velocity and the area of the orifice, we then have as the discharge for each orifice,

A (Area in sq. ft.) × V. (Vel. ft./sec.).

In the case instanced the head is 6 in. (0.5 ft.) and A is 0.441 sq. in. or 0.0031 sq. ft. (*i.e.*, ¾ in. dia.) Then volume discharged

(cub. ft./sec.) $= 0.0031 \sqrt{64.4 \times 0.5}$
$= 0.01736$ cub. ft./sec.
and for two orifices $= 0.0348$ „ „

This means that the disc weighing 378 lbs., or $\frac{378}{450}$ cub. ft., will be cast in $\left(\frac{378}{450} \times \frac{1}{0.035}\right)$ secs. = 24.5.

From actual observations this is cast in 35 secs.

Another case.—Wt. 400 lbs., dia. runner $\frac{13}{16}$ in. (0.0036 sq. ft.).

$Q = 0.0036 \sqrt{64.4 \times 0.5}$
$= 0.0404$ cu. ft./sec. for 2 orifices,

and time $(t) = \frac{400}{450} \times \frac{1}{0.0404}$
$= 20$ seconds.

Actual time 28 seconds.

Case (1). $\frac{\text{Ratio calculated time}}{\text{actual time}} = \frac{24.5}{35} = 0.7.$

Case (2). ditto $= \frac{20}{28} = 0.71.$

The above is open to severe criticism, and does not desire to avoid it, but is again attempting to anticipate it by pointing out that he is well aware that examined by physicist and mathematician it is not sound, from their point of view, but the whole value of the application of theory to the practical side lies in the adjustments and assumptions made. This simple illustration does not take any account of fluid function, internal viscosities and many other factors, but it does fit the case, and any corrections that are desired and that have not been mentioned may be assumed to have been taken into account in the 0.71.

Again, everything depends on the temperature of the iron, but here also, if the previous control has been of the type indicated, the temperature is more or less constant within reasonable limits.

Finally, the author desires to acknowledge his indebtedness to the directors of Messrs. L. Gardner & Sons, Limited, with whom he desires to couple the name of Mr. H. E. Hunter, for permission to publish any details of work carried out in their foundries, and also to express his appreciation of the valuable co-operation, assistance and encouragement given by Mr. Hunter and by Mr. H. Swann.

Scottish Charitable Contributions.

CONTRIBUTIONS TO INFIRMARIES and other charitable institutions have been made for the year 1932 by the staffs and employees of the following firms: Messrs. Blairs, Limited, Govan, £150; Messrs. James Howden & Company, Limited, Glasgow, £202; Lion Foundry Company, Limited, Kirkintilloch, £82; Cameron & Roberton, Limited, Southbank Foundry, Kirkintilloch, £73; Glencairn Metals, Limited, Motherwell, £50; Summerlee Iron Company, Limited, Coatbridge, £1,411 1s. 6d.; Walker & Wilson, Limited, Bolt and Nut Works, Hamilton, £46 4s. 9d.; Blantyre Engineering Company, Limited, Blantyre, £75.

Fried. Krupp Company.

BIG REDUCTION OF OUTPUT.

The report of the Fried. Krupp, A.G., for the year ended September 30, 1932, just issued, states that the period was one of unprecedented business depression. The production of iron ore declined to the level of 1874, that of iron and steel to the position in 1904, and the make of steel at the Guss-stahl Fabrik to the level of that in 1890.

As a result of the currency difficulties of many countries and their isolation through import duties and quotas, the export trade last year was hampered, while inland and external political difficulties prevented the restoration of confidence. As a result the financial year closed with a loss of 19.65 million mks., of which 4.42 millions were brought forward. The whole of this loss has been written off by transfers from the reserve fund, which had accumulated as a consequence of the Krupp family having foregone dividends when profits had been obtained in the post-war period. The results for 1931-32 compare with a loss of 13.42 million mks. in the previous year. The burden of taxes rose from 5.10 mks. per 100 mks. of the turnover in 1930-31 to 6.20 mks. per 100 mks. in the past year, the total value of the turnover in 1931-32 having amounted to 169 million mks., as compared with 265 millions and 389 millions in the two previous years.

Reorganisation.

The endeavours of the company to adapt the operation of the works to the diminished volume of activity were continued with some success, and led to decisive alterations in the organisation and methods of working. The possibilities in this way of overcoming the disproportion between the costs of production and the financial proceeds were almost exhausted without its having been possible to re-establish complete equilibrium between receipts and expenses. A return to profit-earning remains dependent upon a material improvement in the degree of activity.

It was found necessary to reduce the number of persons employed at the collieries from 14,500 in 1930-31 to 11,700 during the year under review. The total production of coal declined from 6,139,802 tons to 4,740,039 tons in the two years respectively, and that of coke from 1,633,708 tons to 1,235,465 tons. In the case of iron ore mining it is stated that the production in the Siegerland and the Lahn district was the lowest last year since the company had operated in those regions. The actual output, including that of the Fernie manganese ore mine, amounted to 141,038 tons, as against 383,958 tons in 1930-31.

Iron and Steel Production.

Concerning the iron and steel works, the report says that the production of pig-iron at the Friedrich-Alfred Hutte was only 45 per cent. of that in the pre-war period, and that of crude steel and rolled manufactures was only 57 per cent. On the average this works was in operation 12 days per month; of the 10 blast furnaces only three were working at any time. At the ironworks in Borbeck both blast furnaces were active during the whole of the year, although at only 40 per cent. of their capacity. In the departments of the Guss-stahl Fabrik the steel plants were operated at 35 per cent. of their capacity and the forges and rolling mills at 35 and 25 per cent. of their capacity respectively. As a result of this state of affairs the production of pig-iron decreased from 933,772 tons in 1930-31 to 472,791 tons last year, that of crude steel from 1,111,889 tons to 684,728 tons and that of rolled products from 815,932 tons to 477,763 tons.

It was possible for the locomotive works to get a share of the few orders which were given out, although prices were very depressed. Competition in the British Dominions was almost impossible owing to the depreciation of the pound sterling, while the prices obtained abroad "only covered a fraction of the costs." In general machinery construction the turnover experienced a decline of 34 per cent. over the previous year.

Metallic Zinc Paint.—Metallic zinc paint, says "Steel," is finding increasing use as a prevention against corrosion. The principal pigment is a metallic-zinc powder, frequently referred to as zinc dust. This powder, produced by a distillation process in specially-designed furnaces, is mixed with zinc oxide in a linseed oil vehicle of the usual type. The adhering power of this paint is very good.

Some Experiences with the Balanced Blast Cupola.

By H. H. Shepherd.

(*Concluded from page* 401, *col.* 47.)

Blast Pressure.

The blast pressure, as measured in the wind belt, varies from 7.5 to 10 ozs., but when the general work in the foundry is running light in weight, it is possible to work at a blast pressure as low as 5 ozs. without any reduction in the temperature or superheat of the metal, once the maximum superheat has been obtained early in the melt at the higher pressures of 7.5 to 10 ozs. These points are clearly illustrated by Fig. 5, which shows the blast-pressure chart record working at 7.5 to 10 ozs., and Fig. 6, which shows the blast-pressure chart record when working at the lower pressure of 5 ozs.

One of the essentials to success in the operation of the balanced-blast cupolas, is that all the tuyeres must be cleaned out thoroughly before each melt, as thin-slag layers collect over them during the melt and, obviously, if the furnace is run from day to day with choked tuyeres, and

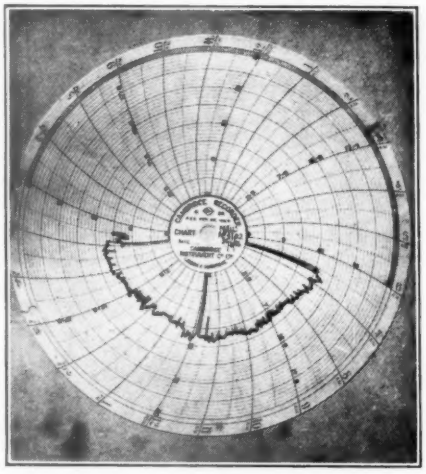

FIG. 5.—BLAST PRESSURE CHART WHEN WORKING AT 7.5 TO 10 OZS.

without checking up to see that the tuyeres are correctly adjusted, one cannot expect to obtain the efficient operation available. As to the effects of the introduction of the balanced-blast cupola upon the physical properties of the iron and foundry scrap, it is very difficult to give any reliable figures. In the first case, owing to the inferior nature of the steel scrap available during the first few months of operation, it became necessary to make several changes in the mixture. Further, the amount of light work and short runners in the foundry materially affect the scrap percentage figures.

It is definitely known that the iron is much cleaner and freer from oxidation and, as a result of which hot-metal tears and cracks have been reduced, and so have unsound leaky castings, while there are many indications that the foundry scrap has been reduced by about one-third of the total scrap. It may be regretted that the writer cannot quote actual temperatures of the metal before and after conversion, but it can safely be said that, after conversion, the temperatures were in the region of 1,450 deg. C. Personally, the author is not concerned about temperature improvements actually, for, after all, it is fluidity that counts, and iron coming from the balance-blast cupola is remarkably fluid.

With regard to carbon pick-up, it was found that if the cupola can run throughout the day without any serious stoppage, and that a given blast pressure can be maintained, the carbon pick-up is rather less than was obtained before conversion, that is, of course, for the same type of mixture, about 0.2 per cent. Before passing over to considering the grey-iron cupola, there is one very important point he emphasised, that it is customary, at any rate in this country, to operate one cupola one day and operate on the second cupola the next day, during which time the first one is re-patched. This is not the case in the Crane malleable foundry. The balanced-blast cupola has to operate every day, there being no suitable alternative cupola. This should be borne in mind when considering what has been said about the effect on the lining.

Grey-Iron Cupola Conversion.

In the case of this cupola it was decided to make a duplex conversion so as to give a melting rate of 2½ tons per hour from a 26-in. bore, and to enable 5 tons per hour to be obtained when required, by opening out the lining to 36 in. Fig. 7 gives details of the alteration. In this case the belt extension amounted to an increase of 18 in. in the depth in order to give a wind belt 6 ft. deep. In order to provide for the higher-melting rate it was necessary to fix six main tuyeres and valves and six auxiliary tuyeres in each of the three rows. All the tuyeres were of the same size as used on the malleable cupola, and were assembled in the same staggered type formation. Five of the main tuyeres are in constant operation, whilst one is closed, the position of the closed tuyere being rotated as previously described. Fig. 8 gives a general view of the converted grey-iron cupola.

In this instance also, the rectangular-shaped tuyere boxes are not in use, they having belonged to the original system. Only three auxiliary tuyeres in each row are required to be of use, so each alternate one is permanently closed off.

COST OF CONVERSION.

TABLE III.—*Cost of Converting the Grey Cupola.*

	£ s. d.
All tuyeres and valves, including freightage	87 0 0
Air belt extension	7 0 0
Welding rod	0 13 6
Acetylene	3 10 0
Oxygen	1 13 0
Labour (180 man-hours)	18 0 0
Total cost	£117 16 6

(Excluding the appropriate extra subscription to the British Cast Iron Research Association.)

The cost of converting the grey-iron cupola is shown in Table III. It will be noted that the total cost of conversion is appreciably higher than was the case for the malleable cupola, but it is easy to understand why this is so since the much larger diameter of 90 in. meant increased labour and material costs; and the fact that it was altered in order to give us 2½ or 5 tons per hour, naturally meant a licence figure approximating to a mean output of ¾ tons per hour.

Operation of the Grey-Iron Cupola.

Before the change over the coke used on the charges consisted of a equally proportioned mixture of the Welsh coke and a cheaper coke, and the total amount of coke required per charge of approximately 1,000 lbs. was 145 lbs. After conversion the cheaper coke was used on its own for the majority of the charges, Welsh coke being used only on the bed and the first few charges. In the case of the malleable cupola the melting practice was very satisfactory on the third day after conversion, a result that was somewhat surprising in view of the danger likely to arise when making changes in connection with very low-silicon mixtures. It was, therefore, expected that the changing of the grey-iron cupola would be a comparative easy matter.

At the outset an attempt was made to operate on a basis-coke ratio of 10 to 1, but here the management met with considerable disappointment, for hot iron was not obtained until some time after the lunch-hour shut down, and this condition prevailed for some few days as it was naturally thought at first that the trouble would be overcome once the correct blast adjustments had been secured. Height of bed and more coke on the charges did not correct the trouble. At the same time, it was realised that there was ample coke per charge already. One peculiar point was noticed, and this was, that the iron was always very hot after the lunch-hour shut down of three-quarters of an hour. This verified that the coke per charge, taken over the whole melt, was ample and these observations led to the consideration of other factors. Eventually,

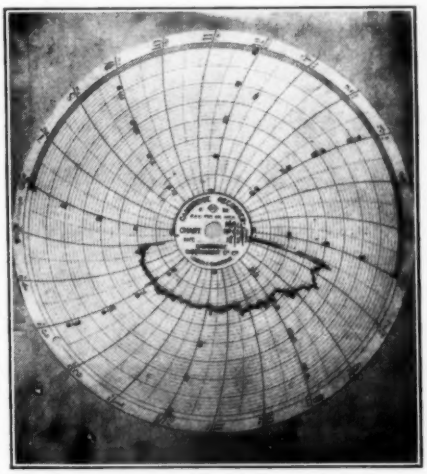

FIG. 6.—BLAST PRESSURE CHART WHEN WORKING AT 5 OZS.

the problem was narrowed down to one of lining thickness.

On referring to Fig. 7 it will be noted that the shell diameter of this cupola is 90 in., and in order to obtain an internal diameter of 26 in. it was necessary to have a brick-lining thickness of 32 in.—a very abnormal condition. The fact that the iron was always much hotter after a shut-down and that the amount of coke per charge necessary before conversion was abnormally high for the type of mixture melted, indicated that during the early part of the melt this exceptionally thick lining absorbed much of the heat that should go to superheating the iron. It can be shown by a calculation that the lining of the grey-iron cupola required four times the length of time required by the malleable cupola (lining 16 in. thick) to reach the temperature of the desired superheat of the metal, since the temperature diffusion through the radiator cupola lining wall is only about one-quarter that of the malleable, and it may be estimated that for every 100 deg. C. increase in temperature of the bore of the malleable cupola, the bore surface of the grey-iron cupola will only rise about 22 deg. C. in unit time.

Having been convinced ourselves that this was

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the cause of dull iron, the trouble was remedied by increasing the amount of coke required per charge by 25 per cent. on the first twelve charges, and it was found that this amount of extra coke at the beginning of the melt provided the necessary extra heat units to raise the bore to the required temperature and to give good hot iron right from the beginning of the melt. A further possible advantage in this direction was obtained by reducing the weight of all metal charges from 1,000 lbs. to 750 lbs.

The above account of the difficulty in obtaining hot metal for the first few days after conversion is given as a matter of interest arising from an abnormal condition, and, at this juncture, the author would like to express his company's and his personal sincere thanks to Mr. Fletcher for the untiring attention he paid to this problem until it was finally solved.

Present Practice.

The bore diameter is kept lined to 26 in. and, as is the case with the malleable cupola, it is an easy matter to do this, as the lining erosion is so much less than before conversion. As regards the consumption of ganister and the saving of bricks, the same remarks apply as given previously for the malleable cupola, the brick saving being, possibly, a little more on account of the different character of the iron mixture used. The coke bed is made up to the level of the top row of auxiliary tuyeres and the height is about the same as on the malleable cupola, namely, 54 in. The writer regards this height, though excessive, as necessary, again to combat the abnormal thickness of the lining. The weight of the coke used on the bed is approximately 850 to 870 lbs. and the first charge of coke is put on after the bed has burnt through. The basis weight of the metal charges is 750 lbs. and the first twelve charges carry 100 lbs. of Welsh coke, after which the charge coke is reduced to 75 lbs., that is, in the ratio of 10 to 1.

The coke ratios, including and excluding the bed, assuming an average melt of 24 tons per day, before and after conversion, and also the saving obtained, are detailed in Table IV.

TABLE IV.—*Monetary Savings Effected on Grey-Iron Cupola through Conversion.*

	Before conversion.	After conversion.
Average coke per charge (1,000 lbs.)	145 lbs.	106 lbs.
Coke ratio, including bed ..	6.2 to 1	8.2 to 1
Coke ratio, excluding bed ..	7.2 to 1	9.7 to 1
Percentage savings of coke per charge ..	27 per cent.	
Monetary Savings.—Normal annual requirements before conversion for 24 tons per day melt, less amount of bed coke = 6,960 lbs. per day × 250 (working days)	775 long tons	
Annual requirements after conversion = 775 tons, less 27 per cent.	566 long tons	
Cost of coke before conversion, using Welsh only at 48s. per ton = 48 × 775 ..	£1,860 0 0	
Cost of coke after conversion if Welsh only used = 48 × 566	£1,358 0 0	
Therefore, savings per annum would be ..	£502 0 0	
Present annual cost of coke, due to using cheaper grade at an average price of 41s. 6d. per ton = 41.5 × 566. . ..	£1,174 0 0	
Net savings per annum = £1,860 − £1,174	£686 0 0 (approx.)	

It can easily be estimated that the total cost of conversion for the grey-iron cupola was paid off in just over 10 weeks, assuming an average saving of a little over £14 per week, and it will be seen that with an output of 125 tons per week the saving is equivalent to a reduction in metal cost at the spout of 2s. 3d. per ton. For a cupola of normal shell diameter, for the output under the same working conditions, the cost would have been recovered in about the same time as for the malleable cupola.

It should be emphasised that if the grey-iron cupola had been working on a normal lining thickness it would be much more economical than it is at present, and the savings in coke would have been even more than obtained on the malleable cupola.

Blast Pressure.

The blast pressure, as measured in the wind belt, is about the same as in the malleable cupola, that is, 7.5 to 10 ozs. When necessary, a pressure as low as 5 ozs. can be used with fairly satisfactory results, but on account of the larger-size cupola it is found best for the blast not to be lower than 6 ozs.

Coke recovery from the bed is about 40 per cent. and it is in good condition. About 14 lbs. of this coke was found satisfactorily to replace 10 lbs. of new coke per charge when tested out for several days. The effect of the balanced-blast cupola in the grey-iron foundry has been to give clean, fluid and high-temperature metal, having a very close grain in the castings but quite easy to machine. This metal has a silicon content of 2.25 to 2.5 per cent. according to requirements, and a phosphorus content of 0.8 to 0.9 per cent. As an example of the fluidity, it is not uncommon to secure metal so fluid that the cores in 36-in. radiator section moulds soften and partly burn before the iron solidifies, and a modification in the core oil and the core design had to be made to counteract this. A further advantage is that such fluid metal cleans itself free from any dirt or sand that it may become contaminated with. In the case of this cupola, it is operated day after day in the same way as the malleable cupola.

In conclusion the writer desires to express his sincere thanks to the directors of his company, Crane, Limited, Ipswich, for permission to give this Paper and publish the information. He also takes this opportunity of extending, on behalf of his company, an invitation for any interested party or individual to visit their works and see the two balanced-blast cupolas in operation. Sincere thanks are also expressed to Mr. J. G. Pearce and Mr. J. E. Fletcher for their kindness in providing some of the information contained in the Paper appertaining to the theory and design of the cupola.

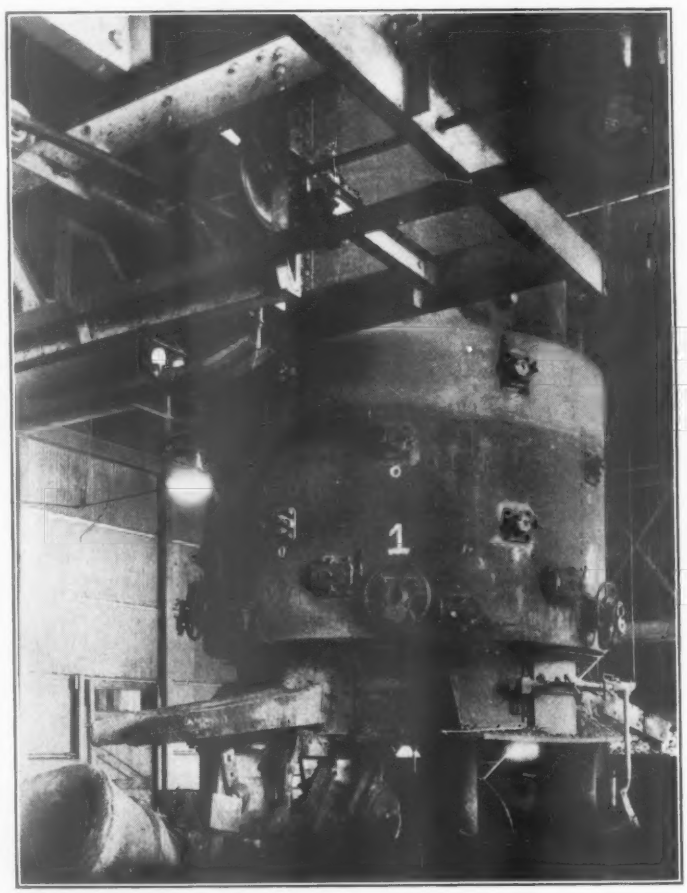

FIG. 7.—SHOWS DETAILS OF THE GREY IRON MELTING CUPOLA AFTER CONVERSION TO THE BALANCED BLAST SYSTEM.

Import Duties Act.

Sub-section (1) of Section 9 of the Import Duties Act, 1932, provides that, with a view to obtaining information as to the condition and progress of trades and industries manufacturing goods which, if they were imported into the United Kingdom, would be chargeable with a duty of Customs under Part I of the Act, the Board of Trade may, before the commencement of any year, publish in the "London Gazette" notice that they will require returns in relation to that year. The Board of Trade gives notice in the "Gazette" of December 16 that returns will be required in relation to the year 1933 in respect of the following industries:—(1) Coke and by-products trade; (2) cement trade; (3) brick and fireclay trades; (4) chemical and allied trades; (5) explosives, etc., trade; (6) iron and steel trade (blast furnaces); (7) iron and steel trade (smelting and rolling); (8) iron and steel trade (foundries); (9) anchor, chain, nail, screw and kindred trades; (10) tinplate trade; (11) wire trade; (12) tool-making and cutlery trades; (13) needle, etc., and metal smallwares trades; (14) hardware, hollow-ware, metallic furniture and sheet-metal trades; (15) small arms trade; (16) engineering trades; (17) electrical engineering trade; (18) cycle trade; (19) railway carriage and wagon building trade; (20) aircraft trade; (21) non-ferrous metals trades (smelting, rolling and casting); (22) finished brass trade; (23) engine and boiler packing and asbestos trades.

The Practical Application of Soda Ash.

VIEWS OF PROMINENT FOUNDRY EXPERTS.

(*Continued from page* 381, *col.* 47.)

Purity, Soundness and Corrosion.

MR. E. W. COLBECK said the author had covered a very wide range of subjects in an admirable manner, but it had naturally not been possible for him to give detailed attention to all the aspects of soda-ash treatment. In particular the question of corrosion of cast iron deserved further consideration. Cast iron not only had to resist the action of strong corrosive chemicals but also the milder action of steam, hot and cold industrial waters, etc., and during the course of the examination of numerous cases of failure of cast iron due to corrosion under comparatively mild conditions, he had been struck by certain features common to most of the instances. For example, there was a similarity between graphitic softening and growth at elevated temperatures, both of which were accelerated by slight porosity and a coarse graphitic structure. Again, there was anodic corrosion or pitting in cast iron which frequently occurred over zones where the micro-structure revealed the presence of non-metallic impurities. This, as was well known, was the most deadly form of attack, since a casting that was otherwise good could be ruined by one or two local perforations. In nearly all cases of corrosion of cast iron the graphitic flakes played a vital part; if these were coarse or long and interconnected they undoubtedly provided an easy channel by which the corroding media might enter and percolate through the casting. It had been his experience that castings made from metal treated with soda ash were, due to their denser structure, finer graphite and greater freedom from non-metallic impurities, far more resistant to attack by liquid media and hot gases. That had been shown by practical experience with castings up to 15 tons. He had had experience of examples of castings in which, with untreated metal, there was pitting right through, whereas in the case of metal treated with soda ash and cast under exactly the same conditions, it had corroded away evenly and had made a profound difference to its life. To sum up the question of corrosion, in his opinion a sound casting was better than many alloying elements when it came to the question of corrosion attack, and if soda ash would make for a sounder casting, as the author had shown, the case for its employment in plant for use under corrosive conditions could not be denied.

MR. J. W. GARDOM said he welcomed anything that would remove some of the difficulties in melting iron. It was in looking through THE FOUNDRY TRADE JOURNAL that he had obtained his first introduction to soda ash, and he obtained some although, unfortunately, it was delivered in tons instead of in cwts.! Therefore, he felt very grateful to Mr. Evans for indicating that this could be used. Nevertheless, he wanted to know a little more about it. His supplies were in powder and he wanted to know how to make blocks. Mixing it with water and allowing it to set seemed effective, but perhaps the author could say whether that was a satisfactory method to adopt. The next point was as to the use of soda ash in an air furnace. Should it be put in early in the charge or after the charge was melted? Further, what was the effect of soda ash when using pulverised fuel. The ash of pulverised fuel was very difficult, metallurgically, to deal with, and he would welcome the results of any experience of treatment of pulverised fuel with soda ash. Following up some of the information given in THE FOUNDRY TRADE JOURNAL with regard to soda ash, he had used it, and although he would not say the results were worse, he could not say they were better than when he did not use it. At the same time, he would not say that was the fault of soda ash. No doubt it was due to his own experience, which only covered about 14 days. What he was anxious to do was to de-oxidise with it. It was true it was not stated in the Paper that soda ash was a de-oxidiser so much as a desulphuriser, but, as stated by Mr. Evans, the passing of gas through molten metal should help in the reduction of oxidation: Mr. Pearce had definitely stated that it was impossible to get gases into metals and keep them there.

Turning to the tables in the Paper, Mr. Gardom commented on the statement that the fluidity of iron is increased with the removal of sulphur, and added that many foundrymen obtained more fluid iron in the feeder when casting by adding sulphur in lump form, so obtaining more fluid iron at this point and increasing the soundness of the castings.

Surely the author was in error in stating that soda ash would improve faulty design! Referring to Table III, which related to white-heart malleable iron, Mr. Gardom said he would like to see the etched photomicrograph after treatment, because he was inclined to think that the white-heart had been turned into a partial black-heart and that the improved results mentioned did not really apply to white-heart iron. On the question of the price of scrap, it was the fact that the price had gone up in certain areas owing to scrap being used to such a large extent in some types of furnaces.

Minimum Quantities possible to Treat.

MR. H. FIELD raised two points. There seemed, he said, to be some question as to whether the action was endo-thermic or exothermic and that would control the volume of metal to which the process might be successfully applied. Reference had been made to castings weighing 5 to 15 tons, and no doubt the bulk of cast iron, regarded from the weight point of view, was cast into heavy castings. From the point of view, however, of very large numbers of castings made in this country, small quantities of iron were treated rather than large. Therefore, the question of whether the action was exo-thermic or endo-thermic would influence not only the output of small foundries but also the output of large foundries making small castings. Could any basic line be drawn as to the volume of metal which could be successfully treated in this way. Could 5 cwts. of metal be treated or must the quantity be 1, 2 or 5 tons? In his own particular case he had been endeavouring to treat about 8 cwts. of metal in batches, but had found that the time required for the process was so long that the metal suffered either because the action was endo-thermic or because the time the metal had to stand rendered it no longer suitable for the purpose in view, namely, the production of extremely light castings in a foundry of very considerable size where the metal had to be carried a long distance. Therefore, he would like to know whether the author was able from experience to say to what volume of metal the process could be applied satisfactorily.

The other point was, perhaps, a criticism. Some photographs had been shown of "inclusions within the metal." Many foundries were not troubled with "inclusions contained outside the metal," if that were not Irish. They did not have to worry about surface defects, particularly in heavier castings from which perhaps ¼ in. or more might be removed, but in the case of small castings the greatest asset in many cases was their appearance and they had to be highly polished without removing much metal. It had been found impossible, however, in his case satisfactorily to remove the soda-ash slag in such a way that the quality of the surface of the castings could be maintained. It was possible under existing conditions to obtain castings which were moderately free from surface defects, but it had not been found possible to remove the slag to a degree which enabled a surface to be obtained equal to that obtained in normal untreated metal. Many surfaces of these castings had to be enamelled, and enamelling was a severe test, but bright polishing and plating were still more severe tests. For these reasons, therefore, he would like some information as to the possibility of removing the slag from treated metal in such a manner as to maintain the high standard of surface appearance which was normally obtained in the light-casting industry with untreated metal.

MR. TEMPLETON remarked that nothing had been said about the reduction in silicon by this desulphurisation process. He tried it some time ago and found that whereas with the untreated metal the silicon content was 2.07 per cent., by the soda-ash treatment this was reduced to 1.83 per cent. It was true that the sulphur content was reduced at the same time by about 50 per cent., but the reduction of silicon was a rather important point, especially in these days, from the point of view of machinability. He, therefore, asked whether it was possible to prevent the reduction in silicon when using soda ash.

MR. LUTYENS, a director of I.C.I. Metals, Limited, invited foundry owners to utilise their experts in overcoming any difficulties they might encounter in making sound castings.

AUTHOR'S REPLY.

MR. EVANS, replying to the discussion, first expressed his thanks to Mr. Pearce for his very kind remarks and for the very valuable contribution he had made to the discussion. Mr. Pearce had mentioned one or two points of considerable importance in connection particularly with the economic side of this question, and he had referred to the fact, which was undoubtedly true, that the majority of blast-furnace irons produced in this country were relatively free from sulphur and that the sulphur problem did not really arise in this case. In this connection he wished to stress the point that the removal of sulphur was only one of the effects of the use of soda ash and that it had very valuable applications even when the sulphur was as low as it was in hematite iron. As Mr. Pearce had said, the majority of the manufacturers of refined pig-iron in this country were actually using the process. Of course, they had a greater sulphur problem than the blast-furnace people, particularly in making low-silicon iron as used in the malleable industry. It was very interesting to know that many of the results mentioned in the Paper had been confirmed by work carried out by the Research Association. He and Mr. Pearce had, of course, discussed these matters from time to time during the course of the work that the Group had done, and it had been very valuable to have independent confirmation of their results.

Manganese and Sulphur.

As to the question of manganese looking after the sulphur, that of course was satisfactory in certain places, but it was necessary to stress the fact that manganese sulphide was not metal and, therefore, it was necessary to keep it out of cast iron if possible, particularly in view of its habit of segregating. If manganese sulphide could be distributed evenly throughout the metal it would not be nearly as harmful as it might be in other conditions, but it had a very harmful habit of segregating and causing patches in the casting, which might prove to be distinctly porous when a pressure test was applied.

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Gas Elimination.

Regarding what Mr. Pearce had said concerning gases in metals, he could quite believe that by passing gases through molten metal none of the gas would dissolve. If one took water near its boiling point and passed air through it, the result was to release much more air from the water, and the same phenomenon probably occurred in molten metal. The gases were, so to speak, in a state of super-saturated solution and it only needed a little agitation to cause them to come away altogether. That gases did occur in metals and cause a harmful effect was evident. Every foundryman was familiar with those little holes in castings with a perfectly clean surface on the inside, and the general body of opinion was that these were due to gases which came out of solution very nearly at the solidification temperature. The great point was to remove such gases whilst the metal was still fluid, so that the gas could get away to the top. The illustrations of the test-bars he had shown—which he agreed were made under quite artificial conditions—were exhibited to illustrate how the agitation which soda ash produced had the effect of releasing the gases which otherwise would remain in solution until it was too late for them to get away through the runner.

He had been particularly interested in Mr. Millington's remarks and the figures quoted for the removal of sulphur in cupola treatment. Mr. Millington had remarked on the fact that he had had as high a reduction as 63 per cent. and as low as 23 per cent. That agreed with his own experience. As to the reduction of sulphur, a figure of 20 per cent. to 40 per cent. could be expected in grey iron by cupola treatment, but a reduction of 60 per cent. was rather exceptional. In low-silicon irons the reduction in sulphur would be less still.

Pearlite Refining.

It was quite true, as Mr. Millington had said, that in the refining of pearlite it was possible to see different degrees of fineness in the same sample, but if the precaution was taken, which the work of Belaiew suggested, of only taking the finest parts of pearlite that could be seen in any given section, that was the correct standard. This whole subject was very interesting and he recommended them to read Belaiew's Papers before the Iron and Steel Institute. So far as the refining action of soda ash was concerned the figures given in the Paper were the results of repeated observations from different tests carried out in different works. They were not based on laboratory tests. Different foundries had made their own tests on this matter and it had been found in many different samples that there was a finer average pearlite structure in the treated metal. As to Mr. Millington's remarks on gases, the ill-effect of gas was due to the uncertainty which it introduced. If the gas happened to remain in solution, all well and good, but if it just happened to come out and to come out in the wrong place, for instance in a vital place in the casting, then it was likely to prove very costly.

The remarks of Mr. Millington concerning the beneficial effects of sulphur in connection with resistance of cast iron to wear were quite true, but here again the factor of uncertainty came into the question. If the sulphur happened to segregate then the castings were bad, but if the sulphur was in such a condition that it could not segregate then the castings would be better. From Mr. Millington's point of view, of course, his comments with regard to not legislating for the machine shop were quite accurate because Mr. Millington was interested in making locomotives and he expected them to remain in service for a large number of years, but if one told the average mass-production motor-car manufacturer that the metal manufacturer could not legislate for the machine shop, it would be interesting to hear what he had to say! In many branches of production, a compromise of some sort was essential.

"Life" of Soda-Ash Treated Metal.

Another matter mentioned by Mr. Millington was the shortened limit of liquidity of desulphurised iron, but personally he had had no experience of that. A number of other speakers had also referred to this matter and he could deal with them together. The fact that iron treated with soda ash was more liquid, was a matter of common observation. Major Freeth had made some very kind remarks regarding the scientific nature of the work that had been done, but this particular matter was one of the questions which had not yet been thoroughly investigated. It was not known absolutely why the iron was more liquid after treatment, but speaking generally he believed most foundrymen would agree that an iron low in sulphur at a given temperature was more fluid than a high-sulphur iron with the same silicon content. In one particular trial, it was demonstrated conclusively that the metal would run for a greater distance along an open channel feeding a pig-bed, with soda-ash treatment.

As to Mr. Deschamps, of course, he had had very long experience in the treatment of iron with soda ash and he had mentioned the question of the exo-thermic reaction which was very closely connected with fluidity. There again, not a great deal of scientific work had been done, but it was a matter of common observation in several different foundries when trials had been carried out that the foundry foreman had remarked that the iron was hotter. The cupola had been run in exactly the usual manner and the general conditions had not been altered at all, but in spite of the time it had been necessary to wait with the metal in the ladle while the slag was removed, it had been remarked that the metal was more fluid and appeared to be hotter when the casting was being poured.

Silicon Losses and Application to Steel.

As to silicon losses, he rather felt that Mr. Deschamps was looking at this from a different point of view. When Mr. Deschamps said he had 15 per cent. less he meant 15 per cent. of the silicon content present. (MR. DESCHAMPS: Yes.) When it was stated in the Paper that there was 0.1 per cent. less, it was meant that the ordinary grey foundry iron containing 2 per cent. of silicon had been reduced to 1.9 per cent. Regarding the efficiency of the reaction at different temperatures, Mr. Deschamps had mentioned that at 1,400 deg. C. there was approximately 45 per cent. to 50 per cent. reduction in sulphur and at 1,300 deg. C. there was a 20 per cent. reduction. So far as his experience had gone the reaction was efficient within the ordinary range of pouring temperatures as used in grey-iron practice. If the temperature was too high then there was hardly any removal of sulphur, and the suggestion that sodium compounds at such temperatures were very volatile was the correct explanation. That undoubtedly was so. If one tried to desulphurise steel the reaction was very violent; it was possible that the steel might be thrown out of the ladle, and it was not safe to carry out the process. As far as our present knowledge went he did not think there was any possibility of desulphurising steel as such, but within a range of temperature from 1,300 to 1,450 deg. C. the reaction was at its greatest efficiency.

Ladle Linings.

On the subject of refractories, he had heard various reports regarding the use of neutral refractories, and he agreed that theoretically they should give better results. In most foundries it was a question of ladle life and cost, and as he had pointed out in the Paper, under ordinary conditions of use soda ash did not reduce the life of the ordinary ladle to less than a day's continuous use, and they were usually re-daubed daily. The trouble occurred when a longer period elapsed, and so far as his personal experience had gone the only real answer to that difficulty was to use an aluminous firebrick, which was very expensive. Nevertheless, friends who had carried out practical trials assured him that the additional cost was compensated for by the longer life.

The best method of adding the soda ash was to put it in the bottom of the ladle, and heating the ladle was an additional advantage. He was unable to give any very complete information with regard to the composition of the slag which was formed because he had not any figures by him at the moment, but so far as the sulphur content was concerned his experience agreed with that of others that a sulphur content of 3 per cent. or a little over had been found in the slag, but the manganese content of the slag varied very much under various conditions.

Corrosion and Sulphur Content.

The remarks of Mr. Colbeck with regard to corrosion were very valuable. Mr. Colbeck and himself had worked very closely together in this matter, but Mr. Colbeck had had a much greater experience on the question of corrosion, and spoke from severely practical experience when he said that a casting treated with soda ash corroded away and wore evenly, and did not have that tendency to form deep pits. It could be taken for certain that these pits were the result of the segregation of manganese sulphide such as was to be seen in the sulphur prints he had shown of the large test-bars, and the even distribution of the sulphur in the iron was undoubtedly a step in the right direction in increasing the life of castings which had to be used under corrosive conditions.

The question of how the soda-ash blocks were made was raised by Mr. Gardom. Experiments had been made on the manufacture of blocks by hydrating soda ash. The disadvantage, however, was that, if such blocks were used in the cupola, as soon as the temperature reached 100 deg., and the water was driven off, the blocks crumbled. That occurred when the hydrated blocks were high up in the cupola, and the blast then carried away a great deal of the soda ash, and it all went up the stack and was lost without having had any effect. Some blocks were on view which had been made by fusing soda ash. This was rather an expensive process, because soda ash was not an easy material to melt and cast. Nevertheless, this method undoubtedly gave the most satisfactory form of block when it was necessary to use soda ash in the cupola as distinct from the ladle. In the ladle there was really no advantage to be gained by going to the extra expense of fusing, and the use of ordinary dense ash in granular form was the cheapest and most satisfactory. He had had no experience of the use of soda ash in furnaces fired with pulverised fuel, and where such furnaces as the Brackelsberg were being used he made the suggestion that the metal should be melted first in the cupola, desulphurised in the ladle and transferred to the melting furnace, or else melted in the Brackelsberg, and treated with soda ash in the ladle as poured from the Brackelsberg furnace. That had actually been done with quite successful results.

The addition of sulphur to the feeder of a casting to increase the fluidity might be a practical dodge in foundry work, but he did not think many foundrymen would commend the practice as desirable, and he was quite certain that users of the castings would not. Definitely, soda ash would not improve faulty design. There was deplorable lack of co-operation between the designer and the foundryman, and he said that because his audience consisted mostly of foundrymen! Soda ash was not a cure-all for every foundry ill, but there were many cases of designs such that it was a matter of chance whether one got a good casting or a bad one. There might be a sudden change of section or a big boss on a thin plate. Anything of that kind introduced a factor of uncertainty, which made one wonder how many castings would come back

after they had been delivered to the user. In such border-line cases soda ash would definitely help. If the quantity of gas in the metal was very much reduced, the chances of producing cavities in the castings was correspondingly reduced, although he did not say the danger was eliminated. Nevertheless, if 5 per cent. more good castings could be produced, surely it was worth while.

Malleable Castings.

It had been suggested by Mr. Gardom that in the samples of white-heart malleable which had been shown with improved physical properties, there was a partial black-heart structure. Although he had not the etched micro-photographs with him, he could assure Mr. Gardom that that was not the case. Speaking generally, he believed it would be agreed that white-heart malleable gave better physical properties in thin sections, and that black-heart had its most important field of application with the thicker sections. He believed he was right in that, although he was open to correction, but certainly the specimens he had shown were definitely all white-heart.

Minimum Effective Ladle Size.

The question whether the reaction was endothermic or exo-thermic was raised by Mr. Field, who had put the whole subject on a very practical basis by asking what size ladle could be used with the process. Experience had shown that the smallest ladle was about 5-cwts. capacity. That referred to grey iron. With a lower silicon iron and a casting of thin section, where a high degree of fluidity was necessary, 5 cwts. was too small a quantity, and in such cases, where, for example, hand shanks holding 1 cwt. were filled direct from the cupola, then the cupola method was suggested as the best. If it were essential that there should be low-sulphur content, then it was necessary to desulphurise the iron and cast it into pig before it was remelted for making the actual castings. That, of course, was an expensive process, but there were many cases where it was essential.

It had also been remarked by Mr. Field that he had had some difficulty in removing the slag completely. That, however, was a difficulty which could be overcome. The surface appearance of castings treated with soda ash—and again he was speaking from repeated observations in different foundries—was smoother and cleaner than that of equivalent untreated castings. For removing the last traces of slag, as suggested in the Paper, a cheap foundry blacking was a very efficient method, especially for removing the slag which seemed to cling to the inside of the ladle, whilst to sprinkle sand across the lip of the ladle when the main portion of the slag had been removed, held back any little traces which might still be floating on the surface. Foundry blacking was remarkably good for this purpose because it absorbed the fluid slag and produced a dry mass which could be held together and prevented from getting into the casting. The reduction in silicon content had been mentioned by Mr. Templeton, who said he had experienced a reduction from 2.07 to 1.83, with a 50 per cent. reduction in sulphur. That again was one of the factors which was not yet fully understood, but with an ordinary grey foundry iron such a reduction in silicon was abnormal. A figure of 0.1 per cent. was on the high side as a rule, and it was frequently less than that.

In conclusion, as to Mr. Lutyens' remarks, Mr. Evans said he had been asked to modify to some extent the suggestion that the Alkali Group would be pleased to send round "experts" to foundries and give advice. The point was better put in this way, namely, that the Group welcomed the opportunity of co-operating with foundry experts in overcoming their difficulties. They did not set themselves up as people who could teach foundrymen their business. Very far from it. At the same time they would be very pleased in any case to co-operate with foundrymen and give them the benefit of such experience as they had so accumulated.

The CHAIRMAN (Sir Harold Hartley, F.R.S.), in bringing the meeting to a close, said an extremely interesting and valuable Paper had been presented, upon which an equally interesting and valuable discussion had taken place. He felt many temptations to take still further part in the discussion himself, but time would not permit. In addition to thanking the author, they would wish also to express their thanks for the opportunity of holding such an excellent meeting in Imperial Chemical House. Mr. Weeks had told him that this was the first joint meeting in London between the British Cast Iron Research Association and the Institute of British Foundrymen, and that made the occasion unique. However, he hoped that this was the forerunner of many such successful meetings. The key to the success of the evening had been Mr. Evans' Paper, and he associated himself with what Major Freeth had said as to the admirable scientific way in which Mr. Evans had treated the subject. At the same time, as would have been realised by everybody, that scientific treatment was combined with a very shrewd practical knowledge of the subject, and everybody must have been impressed by the way which Mr. Evans had dealt with the points which had been raised in the discussion. This, indeed, was a rare occasion on which the producer and the user had come together and put all their cards on the table and discussed their difficulties. It was only by the confidence that was engendered by such a discussion that it would be possible to arrive at the best and quickest solution of the problems. The meeting and the Paper were characteristic of the very generous research policy of that great corporation which was their host that evening. There was a great tradition of research in that corporation, as in the undertakings which formed it, which was the foundation of the success of Imperial Chemical Industries, a success which kept the British chemical industry in the forefront and enabled it to challenge competition with chemical industry in any other country. Moreover, it seemed to him that the meeting was characteristic of the most modern type of salesmanship. Everybody knew that Imperial Chemical Industries were the sole producers of soda ash in this country. The old type of salesmanship tried to find out what the customer wanted and to offer it to him, but it seemed to him that the latest type of salesmanship was typified in Mr. Evans' Paper, and the attitude of the Alkali Group which had been stated by Mr. Lutyens, namely, the desire to go into foundries and show users how to obtain the best results from the use of this material, and as a consequence to place at the disposal of the industry the results of the research work which had been carried out by the Alkali Group. Moreover, Imperial Chemical Industries had added to the indebtedness of all those present by its hospitality, without which the meeting would not have been carried on in such a lively manner to such a late hour. He had never seen a five o'clock meeting last so long and maintained with such activity, which was a tribute both to the excellence of the Paper and the excellence of the hospitality. Therefore, he proposed a very hearty vote of thanks, first to Mr. Evans for his Paper, and, secondly, to Imperial Chemical Industries for their great hospitality.

The vote of thanks was carried with hearty acclamation.

On the motion of Mr. Summerfield, a cordial vote of thanks was passed to Sir Harold Hartley, F.R.S., for presiding at the meeting.

DR. J. G. A. SKERL (British Cast Iron Research Association, Sheffield), in a written communication, said he was very interested in the Paper from several aspects, most of which had been mentioned in the Paper, but there are one or two which he thought should be emphasised.

A large part of the Paper is taken up with the examination of two test-bars made from dirty scrap in an induction furnace. The difference in the two casts being that in one an addition of about 1 per cent. soda ash was made. The test-bar made from the untreated metal is very unsound, whilst the other is perfectly sound. It is suggested that these experiments would have been more enlightening if another bar had been cast using the same dirty scrap, but with a molecular proportion of good cupola slag, say with about 28 per cent. CaO content, equal to the percentage of soda ash added. A better and more practical comparison will then be possible, because any melting of ferrous material under conditions as in the induction furnace, where the conditions are oxidising, will give bad metal full of gas holes, inclusions, etc., unless a slag is present to protect the metal and to clean it. Under practical conditions in an iron foundry, bad limestone practice or percentage in the charge will give oxidised and dirty metal at the spout, but attention in this direction will improve matters very considerably. He did not intend to pursue the metallurgical aspects of the Paper, except to suggest that the refining process of the graphite may be due in many cases to the great affinity of silica for sodium compounds, the former being formed especially under oxidising conditions, as in the experiments under discussion, and also that the relationship of slag and metal in cupola practice is worthy of much greater study than it has received in the past.

Question of Refractories.

The refractories question in regard to the use of soda ash is one of importance, and the author is to be congratulated in his effort not to minimise the difficulties in this matter. Soda ash is one of the most powerful fluxes that can be used, and calls for the use of better refractories in the cupola, receiver and ladle than normally used if as long a life of the lining is to be obtained. A recent Paper by W. J. Rees (Journ., Ceramic Soc., xxxl, pp. 317-324) contains data germane to the points discussed by Mr. Evans. The Paper gives data regarding the lowering of the fusion points of three types of firebricks and a silica brick by blast-furnace slags and by sodium carbonate. It is seen that the sodium carbonate has generally a more potent effect on the fusion point of the bricks than the slags. A *résumé* of the results with sodium carbonate is as follows:—

			Percentage sodium carbonate.		
	Per cent.		0. Deg. C.	5. Deg. C.	10. Deg. C.
Brick I,	38	Al_2O_3	1,730	1,630	1,540
Brick II,	32	Al_2O_3	1,690	1,550	1,470
Brick III,	21	Al_2O_3	1,650	1,500	1,400
Brick IV,	96	SiO_2	1,710	1,580	1,470

The chief dangers encountered in the use of soda ash as a cupola flux is the formation of a thin fluid slag at the surface of the bricks, which, because of its low viscosity, readily erodes the brick and also permeates the pores of the brick, thereby reducing the heat resistance of the greater portion exposed to the heat of the cupola. Normal cupola slags are more viscous at the same temperature, and therefore the slag erosion is not so great. The author is making an assumption in stating that fused sodium carbonate "only makes contact at the slag level," since there is no guarantee that under normal conditions of charging in a cupola that the soda-ash briquette will not be thrown or fall with the charges to the side of the cupola and so melt against the brickwork in the melting zone.

(*Concluded on page* 16.)

XUM

Manufacture of Cast Iron in the Rotary Pulverised Fuel Furnace.

AN ILLUMINATING DISCUSSION.

The Paper reported under the above caption in THE FOUNDRY TRADE JOURNAL, November 10, 1932, was further discussed at a meeting of the South Wales Section of the Institute of British Foundrymen. As the discussion consisted of a series of questions, Dr. MacNair's reply embodies all the technical information disclosed.

DR. MACNAIR, in replying, said, with reference to the action of the ash in the coal, raised by Dr. Jones, there was a considerable diversity of opinion as to what took place. It was claimed on the one hand that practically no ashes were blown out of the furnace, while on the other hand it was suggested that substantially all the ash was blown through. As there was definite evidence in favour of both sides his opinion was a 50/50 one, and it can definitely be said that while considerable proportions are actually blown through, say 60 per cent. at an estimate, there was unquestionably a quantity which must be left inside the furnace. Ash and slag are found in the exit flues and may be seen escaping from the chimney. At the same time it is impossible to conceive that portions of the ash will not be entrapped by the sticky slag and the walls of the furnace. If the ash is basic in character it will more readily tend to slag away the siliceous lining of the furnace. Experience has not yet been sufficient to determine the action of the ash in causing wear on the lining as opposed to the other factors which are more active.

Furnace Linings.

With reference to lining life it was usual practice to find that some 120 to 150 heats were run before renewal was required. The maximum figure known to him was in a furnace in Germany where the regular average was 300 over six successive campaigns. This was no doubt due to the fact that special care was taken with the charges, which consisted of only pig-iron and scrap, but more particularly to the use of only ¼ per cent. of limestone with the charge. The rotary furnace, like most smelting units, makes its own slag, which on the average runs 25 per cent. lime and 50 to 60 per cent. silica. If for a 5-ton charge ½ cwt. of limestone is added containing, say, 50 per cent. CaO, then it must find ½ cwt. of silica from somewhere to form the above-balanced slag. Part of this silica is obtained by oxidation from the metal, but the largest proportion is obtained by washing from the lining. It is perfectly clear that if the limestone addition is increased the large balance required is obtained principally from the lining, thus giving greater corrosion and quicker necessity of relining. Of course, one has to find out from individual practice what is the best proportion of limestone to use for varying charges in order to be able to form a good fluid slag when melting has just been completed. At present a scheme was being worked out at Glasgow whereby it was hoped to give more control over lining life and enable the furnace to be carried on till a suitable stop week for relining occurred.

It is necessary to lie off for a full week for relining. With the non-tipping type it was necessary to remove the furnace from its smelting site and place it in a vertical position on the shop floor for relining. This has the advantage that a spare barrel can be used to replace the old one, while it is being remade. With the tipping type, relining may take place on site, alternatively, it may be taken out of the cradle and replaced as above. The top-end cone is removable to allow for ease of relining. When the furnace is sufficiently cold the outer glazed and ferruginised surface is chipped away, templates are placed in position, and the fresh refractory tamped in. Some misgivings may be raised as to the cohesion of the old and new refractory, but no trouble has ever been experienced from this cause. When working, the temperature gradient across the refractory is very steep. The inside working surface must be approaching 1,650 to 1,700 deg. C., but it is possible to place the hand on the outside shell. There is only about ⅛ in. of refractory immediately below the inner skin, which is fired at any time. The remainder of the refractory is unaltered, except in so far as moisture is driven off. By completely removing this skin one can thus reform an excellent refractory lining.

Oil-Fired Furnaces.

With reference to fuel oil instead of pulverised coal, raised by Dr. Jones, there was no doubt that fuel oil could be satisfactorily used. It was more expensive, however. For smaller-sized furnaces it was probably more economical. Oil tended to give a non-luminous flame, which was non-radiant, whereas it was well known that luminous flames were more efficient in giving satisfactory heat transfers. This, however, can be easily overcome with oil by working at conditions slightly under complete combustion, which, of course, give a rather heavier yield. The question of using a mixture of oil and pulverised coal was raised, and Dr. MacNair thought that such would have special advantage in small sizes owing to facilities in transport from a central depôt, which were more difficult in the case of pulverised coal only. He had no experience of its use, however, but it might form a very interesting development in the future.

Coal and Air Mixtures.

With reference to the methods used for getting good mixture of coal and air, Dr. MacNair said that in the Brackelsberg type swirling vanes were used, both in the primary and secondary streams, which caused the coal and air to have different relative velocities. In the Sesci type the incoming stream is forced against a grid, which causes considerable turbulence just before passing into the furnace proper. No trouble had been experienced with choking burners. As a matter of fact, the burner in the Brackelsberg furnace at Glasgow had now done some 50 melts and had given no trouble, being at present as good as the day on which it was put in. Although made of cast iron, the velocity of the outcoming stream was greater than the rate of propagation of flame, so there was a clear space of 6 to 9 in. before combustion started. The burner zone was thus always kept reasonably cooled by the incoming stream. It was understood, however, that some trouble was occasionally experienced with the Sesci-grid type burner, which required periodical replacement, due to burning down.

Dealing with the question of the action of sulphur and gases raised by Mr. Galletly, it was said that oxidation is bound to occur, and does occur, as shown by the slight loss of carbon, silicon and manganese. If there was an excess of air used for combustion, then direct oxidation will occur. On the other hand, if the correct air ratio is maintained to burn all the coal to carbon dioxide, oxidation will still occur, as CO_2 is oxidising in nature towards iron. The equilibrium conditions vary with temperature, but at temperatures above 600 deg. C., where oxidation becomes more active, the value of the equilibrium constant is about 70 per cent. CO and 30 per cent. CO_2. If there is relatively more CO_2 present than the above ratio, and one would have extremely poor combustion condition if there was not, then oxidation is bound to occur. Once the metal was melted and covered with slag, direct action between the gas and metal is impossible, and conditions with regard to the metal are determined by the nature of the slag. The slag is progressively lowered in iron oxide, which gives deoxidised metal, thus minimising the bad effects of the melting-down stage.

Sulphur Increase.

The same can be said about sulphur in the gases. During melting, sulphur will be increased slightly if the coal contains over 1 per cent. of sulphur, but after covering with slag, reactions take place in the direction of sulphur removal. Under normal conditions it is generally found there is a slight pick-up in sulphur, say, if 0.07 per cent. is charged, then it may be anticipated that the tapping metal will contain about 0.09 per cent. On the other hand, by stewing this metal sulphur is reduced, and on one occasion where a special test was carried out sulphur was continuously reduced from 0.09 to 0.03 per cent.

With reference to the 3 per cent. coke used with the charge, that was a correcting addition, required by the use of considerable quantities of steel scrap and the rather heavier carbon losses encountered when smelting borings. The approximate internal size of a five-tons furnace varies with the type. For the Brackelsberg furnace it is about 20 ft. long by 2½ ft. dia.; with the Sesci about 18 ft. by 5 ft. dia. The question of flux raised by Mr. McClelland was most important. It had already been touched on above. Limestone was used, and the usual quantity charged was 1 per cent by weight of the metal used. In answer to a question by Mr. Galletly as to the size of the orifice for inserting the burner, it was said to vary from 16 to 36 in., according to the size of the furnace.

When tapping the metal, of course, a small quantity of slag came over as the tap passed the slag level, but this was negligible and could easily be skimmed off the ladle. Once this point was passed no more slag came out until the end of tapping was reached, when the furnace was tilted back and all the slag discharged from the opposite opening.

Basic Linings.

The use of basic linings had been examined and work was continuing both in this country and several places on the Continent. Dr. MacNair expressed it as his opinion that little advantage was likely to accrue from the replacement of silica with basic metal such as dolomite or magnesite. In the first place it was more expensive and, while it was also more refractory, it was equally, if not more, susceptible to slagging action, which was a more important factor in causing breakdown of lining material. There was no metallurgical advantage to be gained by smelting cast iron in a basic furnace. It was impossible to remove phosphorus before practically all the silicon had been oxidised from the metal. As silicon was a vitally important controlling element in cast iron, it would have to be re-added at a heavy expense and the certainty of again reducing phosphorus to the metal if the covering slag had not been removed. There were certainly possibilities of a basic lining so far as steel smelting was concerned, but a brief examination had indicated that these were doubtful owing to certain difficulties. It is known from open-hearth practice that wear and tear on a basic lining is much more severe, a larger quantity of slag has to be formed with consequent increased blanketing effect, a basic furnace must be worked on under chemical control and the flux consumption is much greater.

With reference to the slag tending to lag behind during rotation, it was said that rotation

was very slow, being of the order of one revolution in 1½ min. Dr. MacNair had watched the furnace in operation many times and had never seen the slag breaking so as to cause exposure of the metal.

Anthracite or Soft Coal as Fuel.

Mr. Hird had raised a very interesting point and one aspect about which there was some difference of opinion when he asked for an account of the difference between burning anthracite and bituminous coal. When burning anthracite on a grate one gets a short flame due to the low volatiles. It is a totally different matter burning coal in pulverised form such as is done in the rotary furnace. Here the length of the flame is determined by the rapidity with which the coal is burned, that is the rate with which oxygen can get to the particle and carbon dioxide be dispersed from it. Finer grinding gives a larger area for the same weight of coal, and thus a greater surface for reaction with quicker combustion. Turbulence by bringing oxygen to and taking reaction products from the coal particle will shorten the flame or combustion zone. These factors are outside the type of coal used as they are of mechanical importance so they can be neglected in considering the type of flame produced, though they may have an actual significance in particular installations.

The quantity of preheat in the air is an important factor in determining the temperature and producing longer or shorter flames. Anthracite has an ignition temperature of about 450 deg. C., while bituminous coal is much lower at 350 deg. C. The stream of air carrying the coal therefore cannot exceed the above temperatures respectively. If it be assumed that each coal is carried by a stream of air approaching the above temperatures, then combustion would be started equally readily once a hot surface was reached so that the length of flame would be similar, but owing to the extra preheat in the air there would be a higher temperature reached with anthracite. Accordingly as the temperature of the air was less than these figures, combustion would be later in starting and the final flame temperature lower. Although combustion would be somewhat later in starting the actual length of flame would be similar owing to the very rapid heat generation once ignition has taken place. This quite outbalances the small advantage of the 400 deg. C. preheat.

Cenospheres.

However, the difficulty associated with the limit of temperature on the air stream carrying the coal may be mitigated by using a double air stream. The fine coal can easily be carried by a quantity of air equal to 25 per cent. of the total required for combustion. This is limited as before to 350 and 450 deg. C. respectively for bituminous and anthracite owing to the liability to preignition in the tubes. There is, however, no limit to the temperature of the secondary stream, which does not come in contact with the coal until the ignition chamber is reached just beyond the burner. The only limit to this is the quantity which can be obtained by the conditions of regeneration. Actually there would still be a balance in favour of anthracite owing to the somewhat higher temperatures possible in the primary stream. In dealing more specifically with rotary furnaces, however, it should be mentioned that in the type where anthracite is recommended all the combustion air is supplied with the coal so that 100 per cent. of the air is limited to 450 deg. C. In the other type only 25 per cent. of the air is thus supplied, and with bituminous coal is limited to 350 deg. C., whereas the remaining 75 per cent. has no upper limit.

There is, however, another most important aspect which makes bituminous coal much more desirable than anthracite when burned in pulverised form. Whenever the coal reaches 350 deg. C. the volatiles are suddenly evolved and quickly combusted owing to the rapid reaction between gas and gas as opposed to the slower heterogeneous reaction between gas and solid. This evolution splits up the small coal particle into still smaller pieces and forms cenospheres which have a larger reaction surface, thus directly increasing the rate of combustion between the air and the solid carbonaceous material of the coal. As a consequence of this ignition takes place earlier and easier, as is well illustrated by the fact that when burning anthracite it is necessary to start off with bituminous coal. Although no figures are available, it is also probable that the splitting up of the soft coal will give quicker combustion and in reality production of a shorter flame than is possible with anthracite where the coal particle has to be gradually burned away from the outside inwards.

The question of alloying additions could be answered in a general way by saying those which were not oxidised, such as nickel and molybdenum, could be added to the bath at any time during the melt, either with the charge when just melted or before tapping. Easily-oxidised additions, such as silicon, manganese, chromium, etc., were best added in lump form as ferro alloys just before tapping. The high superheat and rotation of the furnace ensured their rapid solution and even mixing throughout the molten metal. Practical experience had shown that additions of ferro-silicon and ferro-manganese could be made without loss provided the metal was tapped within about 10 minutes.

American Symposium on Steel Castings.

The presentation and publication of the ten extensive technical Papers comprising the Symposium on Steel Castings have been sponsored jointly by the American Foundrymen's Association and the American Society for Testing Materials, the chief purpose being to provide the engineering profession with authoritative information on the properties of steel castings. Carbon-steel and alloy-steel castings are covered. The first two Papers give, respectively, a general survey of the industry and statistical data on steel-castings production in the United States. Then follows a contribution on the design of steel castings, which emphasises the importance of co-operation between designer and founder and discusses extensively contraction and crystallisation phenomena under such headings as crystal formation, feeding of sections, effect of heat transmission, deep pockets, linear shrinkage, etc.

A Paper entitled "Purchase Requirements for Steel Castings, with Notes on Physical Properties in Test-Bars and in Commercial Castings," follows. This explains design factors influencing test-specimen results, chemical limitations for carbon steel and summarises the A.S.T.M. and other specifications for carbon-steel and alloy-steel castings. One of the most extensive Papers gives physical and mechanical properties of some well-known cast steels. This presents a comprehensive correlation from many sources, both domestic and foreign, of data on the more frequently ascertained physical properties, as well as on magnetic, endurance, creep and other properties. The data given cover the various carbon steels and alloy steels which are cast. Representative properties of cast medium pearlitic steels are thoroughly reviewed. Involved are pearlitic carbon and low-alloy steels, containing various percentages of molybdenum, vanadium, chromium and nickel, chromium steels for high temperatures and pearlitic manganese steels.

A technical Paper on "Castings of Corrosion-Resistant Steels" gives extensive data on the principal classes of these alloys, covering physical properties at room and elevated temperatures, machining and welding behaviour, coefficient of thermal expansion, melting point, maximum temperature for safe use, etc. This contribution also includes a discussion of general considerations affecting alloy selection and it outlines the features of the several alloys. Other Papers cover austenitic manganese steel castings, problems and practices in the heat-treatment of steel castings and fusion welding as related to steel castings. The latter gives much test data on cast steel welded by the arc, oxy-acetylene and atomic-hydrogen methods.

Extensive oral and written discussion adds to the value of the Papers, presenting a broader view of the subjects. Diagrams, charts and tables have been extensively used by the authors to enable a quick and clear presentation of the data. The Symposium on Steel Castings carries 254 pages; is bound in a heavy paper cover. Copies, at $1.00 each, can be obtained from the American Society for Testing Materials, 1315, Spruce Street, Philadelphia, or the American Foundrymen's Association, 222, W. Adams Street, Chicago.

American Foundrymen's Association Annual Meeting.

During the 1933 annual convention of the American Foundrymen's Association in Chicago, the week of June 19, there is to be a joint meeting of the A.F.A. and the American Society for Testing Materials. This is scheduled for Friday morning, June 23, at The Stevens. The joint meeting will be devoted to a technical discussion on specifications and tests for cast iron, participated in by leading metallurgists and testing experts in this important field. The primary object of this meeting is the presentation to founders of practical information on existing specifications for cast iron and methods of testing in order that there may be a better understanding of engineering requirements concerning this product. Among the points to be covered are the following:—

(1) Relationship of A.S.T.M. and A.F.A. in the development of specifications and tests.
(2) Significance of testing cast iron and limitations of testing.
(3) Correlation of test-bar and casting.
(4) Transverse and tensile tests.
(5) Discussion of A.S.T.M. specifications for grey-iron castings (A 48-32 T).
(6) Mechanism of testing—accuracy, calibration, effect of speed of operation.
(7) Factors in the production of test-bars.
(8) Value of hardness testing for control of product.
(9) Wear and machinability tests.

This meeting falls in very appropriately with the symposium on cast iron which will be a technical feature of the A.S.T.M. annual meeting.

The A.F.A. 1933 annual convention and exhibition will immediately precede the 36th annual meeting and second exhibit of the Society. The week beginning June 19 has been designated Science Week by the Century of Progress administration. Several scientific bodies or their divisions will be holding meetings during this week and the A.F.A. will co-operate with these in arranging programmes of international participation which will be given.

The choice of Friday, June 23, as the time of the joint A.F.A.-A.S.T.M. meeting makes it convenient for A.S.T.M. members who will be going to the A.S.T.M. annual meeting to advance their departure date and attend the joint Friday meeting.

Turbine Blades.—In the last few rows of blades in large turbines, says "Steel," severe erosion of the blade material takes place along the back of the inlet edge of the blades, and it has been found that a coating of the cobalt-tungsten-chromium-iron alloy (stellite) on the affected area, greatly improves the life of the blades, according to research work carried out by Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa.

XUM

This Week's News in Brief.

Trade Talk.

DURING THE YEAR the employees of the Mirrlees Watson Company, Limited (Engineering and Foundry Departments) subscribed towards infirmaries, convalescent homes and other institutions a sum amounting to £333 15s.

THE FIRM of E. S. Stead, ironfounders, of St. John's Foundry, Cleckheaton, closed down at the end of the year on the retirement of Mr. Edwin Stead, and the premises have been taken over as a warehouse by Messrs. Alfred Hall, Limited, general ironmongers.

MESSRS. MAVOR & COULSON, LIMITED, Glasgow, have received a large order for coal-cutting machinery for the production of coke required for the new steelworks at Pretoria. The contract has been secured in the face of strong competition from American firms.

THE MOOR LINE, of Newcastle, has ordered two steamers of 8,500 tons deadweight from the Burntisland Shipbuilding Company. The vessels will be the first to be propelled by White's patent combination engine, which is based on reciprocal and turbine principles.

MESSRS. DUNN & COMPANY, LIMITED, Lossiemouth, launched one of their latest-type motor-driven drifters, the "Maggie Fleming," for local owners. This type of boat, owing to the economic unkeep and running costs, is rapidly superseding the old type of steam drifter.

MESSRS. GEORGE BROWN & COMPANY, LIMITED, Greenock, launched the motor coaster "Actuosity," which they have built to the order of Messrs. F. T. Everard & Sons, Limited, London. The vessel will be fitted with Diesel engines by the Newbury Diesel Company, Limited, Newbury.

MEETINGS OF SHAREHOLDERS in Messrs. J. & E. Hall, Limited, engineers, are to be held on January 12 to consider proposals for the reduction of the capital from £800,000 to £658,000. The reduction will be effected by returning £1 per share to the preference shareholders and 4s. per share to the ordinary shareholders.

ACCORDING TO A REPORT from Ottawa, a Winnipeg syndicate has negotiated an agreement with the Soviet Government providing for the exchange of Canadian cattle and hides for Russian petroleum products and anthracite coal. The agreement cannot go into effect until it is approved by the Government.

THE PARTNERSHIP between Messrs. A. H. Wilson and N. F. Ward, carrying on business as steel merchants, at Gibraltar Steelworks, Bowling Green Street, Sheffield, under the style of Jonathan Shaw & Company, has been dissolved by mutual consent. Mr. A. H. Wilson is continuing the business under the same style.

MESSRS. F. J. BALLARD & COMPANY, LIMITED, of Tividale, Tipton, have just concluded an arrangement with the Karges Hammer Maschinenfabrik, of Brunswick, whereby they will in future manufacture at Tipton the specialised machinery for the canning industry developed by the latter concern during the last 50 years in Germany.

MESSRS. VICKERS-ARMSTRONGS, LIMITED, Elswick, Newcastle-upon-Tyne, have received a contract from the London & North Eastern Railway Company for the removal for repairs of two pairs of steel gates at the 80-ft. lock entrance to Middlesbrough Dock, and also for the provision of new direct-acting hydraulic operating machinery for the gates.

THE BIRMINGHAM CITY COUNCIL has accepted the tender of the United Electrical Company (Birmingham), Limited, of £11,078 for power and electrical-charging equipment at the Montague Street Works. The tender includes engine plant by Messrs. Belliss & Morcom, Limited, and electrical plant by the General Electric Company, Limited, of Witton.

THE DANISH STATE RAILWAYS, according to the "Ekstrabladet," are going to place an order for steel rails in Britain. The value of the order, it is stated, would be 3,000,000 kronor, and it has usually been placed in France. The newspaper states that the order is now in the possession of the Danish Foreign Office and will enter into the trade negotiations that are now proceeding between Britain and Denmark.

MESSRS. ASHMORE, BENSON, PEASE & COMPANY, LIMITED, of Stockton, have secured a contract from abroad for the construction of conveying plant for handling raw material, such as iron ore, coke and limestone, for blast furnaces, together with crushing plant and auxiliary equipment. Other important contracts which the firm have secured in the last few days include a chemical plant for Japan and an ore transporter-bridge crane of the rope-trolley type for South Africa.

THE STAFF of the United Steel Companies, Limited, at Scunthorpe, Lincolnshire, were asked in June, 1931, to accept a reduction in salary, the directors promising a review within twelve months. At the end of this period it was not found possible to consider any change in the arrangements arrived at, but the directors have recently considered the position and the staff have been informed that it has been decided to restore 25 per cent. of the reduction as from the beginning of the New Year.

A PAPER OF very great topical interest will be read by Dr. A. B. Everest, of the Mond Nickel Company, Limited, before the Wolverhampton Centre of the Institution of Automobile Engineers at the Victoria Hotel, Wolverhampton, at 7.30 p.m. on Tuesday, January 17, on the subject of "Alloy Cast Irons in Automobile Construction." Dr. Everest will also read his Paper before the Western Centre of the Institution at the Merchant Venturers' Technical College, Bristol, on Thursday, February 2, at 7 p.m.

AN AGREEMENT has been entered into with the New Consolidated Gold Fields, Limited, to act as managers of the Buell Combustion Company, Limited, Aldwych House, Aldwych, W.C.2, in so far as the application of the Buell pulverised-fuel system to land installations is concerned, which business will be conducted from their new registered offices at 49, Moorgate, E.C.2. Messrs. Samuel Hodge & Sons, Limited, who previously held both the land and marine rights of the Buell pulverised-fuel system, will now confine their activities so far as this system is concerned to its installation for marine purposes.

Personal.

MR. THEODOR PETERSEN has been appointed a director of Callender's Share & Investment Trust, Limited.

MR. F. J. BALLARD, of Messrs. F. J. Ballard & Company, Limited, Tividale, Tipton, has been awarded the O.B.E., the honour being announced in the New Year's List.

MR. W. C. WATSON, general manager of the Forth Banks Locomotive Works in Newcastle of Messrs. R. & W. Hawthorn, Leslie & Company, Limited, has completed 50 years' service with the company—22 in the capacity of general manager.

MR. AND MRS. MATTHEW M'NICOL, of Camelon, Falkirk, have just celebrated the sixtieth anniversary of their wedding. Mr. M'Nicol has worked as a moulder in many of the foundries in Falkirk district. He entered the Falkirk Iron Company when only ten years of age. He retired from the firm of Walker, Hunter & Company, Limited, Port Downie Foundry, after 20 years' service, about seven years ago.

MR. GEORGE K. WARD retired on December 31 from the directorate of Messrs. William Denny Bros. & Company, Limited, Leven Shipyard, Dumbarton. Mr. Ward served his apprenticeship in the Leven yard, and then went to U.S.A., where he served with the Union Iron Works, San Francisco and also with Lloyd's Register of Shipping. In 1905 he was appointed assistant manager to Messrs. Denny Bros., and in 1911 he was made a partner. He joined the directorate in 1919.

MR. A. M. WISEMAN, the British Trade Commissioner at Toronto, is now in this country on an official visit. Mr. Wiseman will be available at the offices of the Department of Overseas Trade on January 16 to 24, for the purpose of interviewing firms interested in the export of United Kingdom goods to Canada. Subsequently he will visit a number of industrial centres in the provinces.

SIR HOLBERRY MENSFORTH has been elected a director of Edmundsons' Electricity Corporation, Limited, and of the Shropshire, Worcestershire & Staffordshire Electric Power Company, Limited, and has been appointed chairman of each of these companies. In order to enable him to devote the necessary time to his new activities, Sir Holberry Mensforth will resign the chairmanship of the English Electric Company, Limited, but will remain on the board.

New Companies.

Solusal, Limited, Craven House, Kingsway, London, W.C.2.—Capital £5,000. Metallurgists. Directors: W. B. King and L. G. Grace.

Richards Ironworks, Limited. — Capital £6,000. Directors: W. F. Cockrell, S. S. G. and C. S. Richards, 56, Kirkley Cliff Road, South Lowestoft.

Thomas Ibbotson & Company, Limited, 16, Wellington Street, Sheffield.—Capital £2,000. Cutlery manufacturers. Directors: T. and Mrs. E. Ibbotson.

Samuel Fearnside & Sons, Limited, Albert Foundry, Greengate Road, Keighley. — Capital £6,000. Ironfounders. Directors: James, John, S. and D. Fearnside.

Poplar Foundry, Limited, Poplar Foundry, Higher Lane, Longridge, near Preston.—Capital £5,000. Iron and brass founders. Directors: S. Smith and R. B. Duckworth.

Aluminium Power & Light (Foreign Patents) Company, Limited. — Capital £20,000. Solicitors: Ashurst, Morris, Crisp & Company, 17, Throgmorton Avenue, London, E.C.2.

Ayedeecee Metals (Parent) Company, Limited.— Capital £15,000. Directors: G. Hughes, A. J. Wakelin, C. E. Denney, F. S. Simons, 112, High Street, Mertyr Tydfil; W. B. Harris.

English Metal Powder Company, Limited, 22, Bloomsbury Street, W.C.1. — Capital £10,000. Directors: A. Le Vay Lawrence, H. Le Vay Lawrence, J. S. Holmes and H. Meyersberg.

Richardsons Westgarth-Brown Boveri, Limited, Hartlepool Engine Works, Hartlepool. — Capital £10,000. Engineers. Directors: R. S. Middleton, G. Robson, M. G. S. Swallow, S. W. Brown and A. C. Eborall.

Alex. Chaplin & Company, Limited, Empress Road, Loughborough.—Capital £100. Lifting and conveying machinery makers. Directors: W. H. Purnell, H. H. Moore, A. Atherton, W. N. Weston and F. M. Morris.

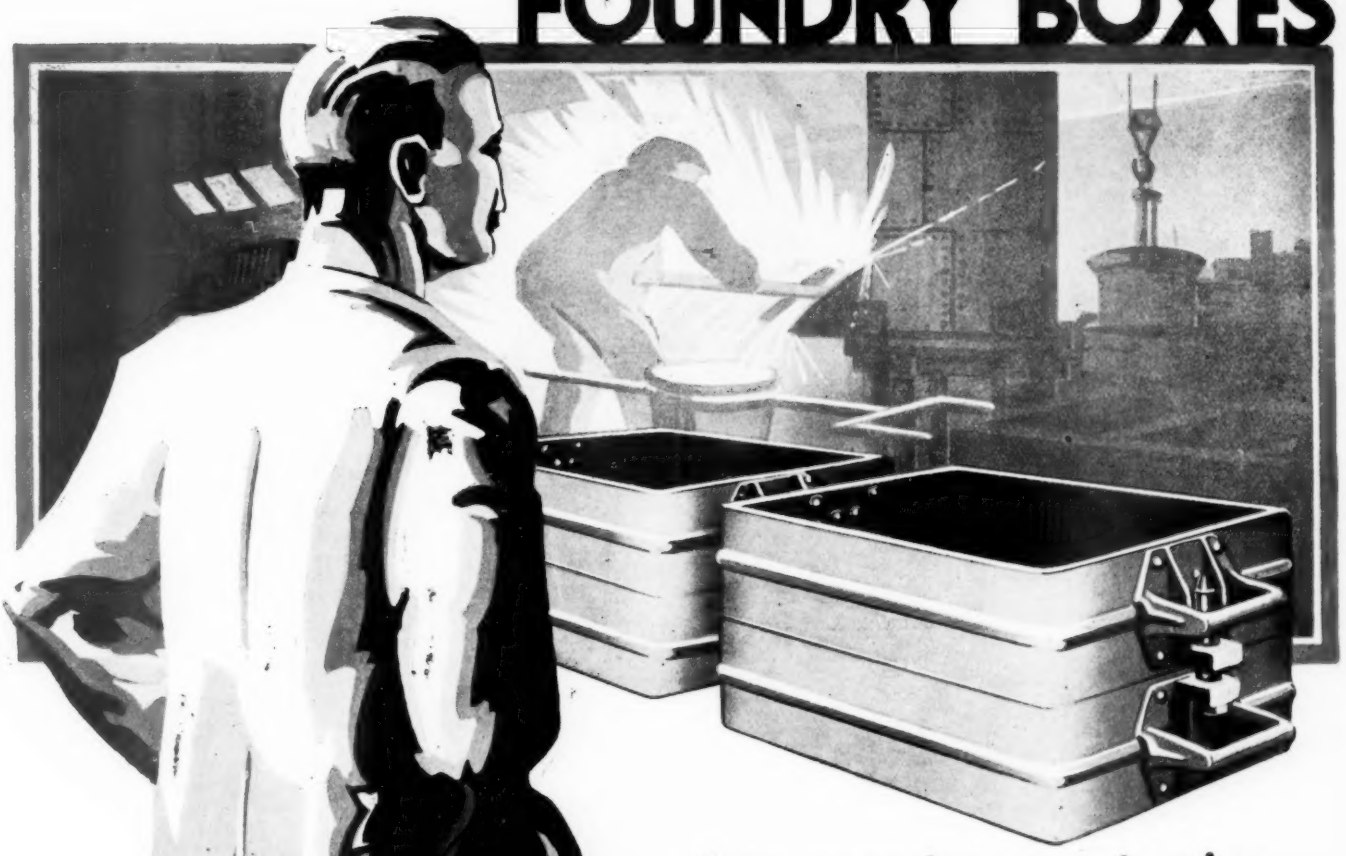
Falkirk Foundry Industry.

On what has proved to be the worst year ever experienced in the light-castings industry in Falkirk, the foundries in the town closed down on December 30 for the annual New Year holiday. As a result of the prevailing depression in the light foundries the holiday will be prolonged. In one or two cases work will not be resumed for ten or twelve days, but as a general rule the foundries will restart on January 9. In the Bonnybridge district the holiday has covered both Christmas and the New Year, and the works which closed on December 23 resumed yesterday. The last year has been a year of difficulty and uncertainty in the light-castings industry in Falkirk and district: export trade, upon which some of the leading firms mainly depended, has dwindled to very small proportions owing to the world depression and the increase of manufacture of light goods in other home centres. The effect of the imposition of the de Valera tariffs has been practically to eliminate the export trade with the Irish Free State, as the Free State merchants have adopted the policy of buying goods only for immediate requirements, and stopped all regular stock buying. The competition for such orders as have been going, price-cutting has been keen, and in some cases unremunerative prices have been accepted in order to keep the foundries open.

Most of the Falkirk foundries have been on short-time working for most of the year, and in many leading works the moulders have been employed for only four days per week. The best period of 1932 was during October and November, and during that period 400 of the 1,400 men on the idle list of the Ironfounders' Workers' Association were reabsorbed into employment in a period of eight weeks. Since then there has been a falling-off again, and once more the ranks of the unemployed moulders have been increased.

The protective tariffs imposed by this country have had the effect of reducing the importation of foreign baths to a minimum, and in this direction the founders have derived some benefit, but the actual demand for baths is decidedly less than it was two or three years ago. Under the prevailing conditions the ironfounders find it impossible to forecast the prospects for the future, although, of course, they are hopeful that 1933 will be more prosperous than has been 1932.

FOUNDRY BOXES



...that speed up production for the Modern Foundry—

One of the greatest improvements you can introduce into your foundry is the STERLING ROLLED STEEL MOULDING BOX . . . . the result is speed and economy all round. Your moulders will put down more moulds per day because of the light and easy handling properties of these boxes.

You will be sure of producing accurate castings because STERLING BOXES maintain their accuracy permanently. Also your moulding costs will be halved—STERLING BOXES stand up to heavy service, anywhere.

Sterling

UP-TO-DATE

MOULDING BOX EQUIPMENT

Save their cost in a few months, and are obviously a sound investment for any foundry.

STERLING FOUNDRY SPECIALTIES LTD.,

WORKS— BEDFORD.

LONDON OFFICE:— 13, VICTORIA STREET, S.W.1.

Agents at GLASGOW and MANCHESTER

XUM

Raw Material Markets.

Little business is passing in the iron and steel markets, owing to the effect of the holidays, which are still in force in the Scottish area. A spirit of quiet optimism is, however, noticeable in all centres, and producers are confident that there will be an expansion in trade once the restrictive effect of the seasonal holidays is shaken off. Prices remain generally unchanged.

Pig-Iron.

MIDDLESBROUGH.—There are indications of an improvement in the Cleveland pig-iron industry. Much shorter holidays were taken this year at most of the foundries and steelworks than at Christmas, 1931, and little iron had to be put into stock. Bookings for January show considerable improvement, and the end-of-the-month delivery figures should give the manufacturers cause for satisfaction. Prices remain unchanged, at exactly the same levels as those ruling a year ago, viz., No. 1 Cleveland foundry iron, 61s.; No. 3 Cleveland G.M.B., 58s. 6d.; No. 4 foundry, 57s. 6d.; No. 4 forge, 57s. per ton.

On the whole, short-period booking is predominant in the East Coast hematite market, few long-term contracts having been negotiated. Indeed, producers are unwilling to commit themselves far ahead at the uneconomic prices now ruling, which are 59s. per ton for mixed numbers and 59s. 6d. for No. 1 quality. The West Coast hematite market continues firm, Bessemer mixed numbers remaining at 66s. per ton.

LANCASHIRE.—Normal trading conditions have not yet been resumed in this area, and there has been little or no business to test the market. The effect of the seasonal holiday has been accentuated by the usual stock-taking operations now in progress at many of the consuming works, and deliveries of pig-iron have been accordingly whittled down. Prices are nominally unchanged.

MIDLANDS.—New business has so far been very limited. Many of the ironfounders in this area have not yet re-opened their works, the demand for their products having yet to show improvement. Quotations remain unchanged at 62s. 6d. for Northants No. 3 and 66s. for North Staffordshire, Cleveland, Derbyshire and Lincolnshire No. 3, delivered to Birmingham and Black Country stations.

SCOTLAND.—All movement of pig-iron has temporarily ceased, owing to the New Year holiday, which will continue for another week or so, according to the state of activity at each individual works. Prices remain as follow:—No. 3 Scottish foundry iron, 67s. 6d., f.o.t. furnaces, with 2s. 6d. extra for No. 1; Middlesbrough and Northamptonshire No. 3, 54s. and 53s. respectively, f.o.t. Falkirk.

Scrap.

In the Cleveland scrap-iron market the continued demand from consumers has stiffened prices, ordinary heavy cast iron being now worth about 38s. 6d. per ton, with machinery quality at about 42s. Midlands users have also been buying to a greater extent, and quotations in that area are firm at 47s. 6d. for heavy machinery and 36s. for clean light scrap. In South Wales heavy cast iron has a fair demand at 42s. 6d., with machinery scrap quiet at about 47s. 6d. In Scotland, in spite of the suspension of deliveries over the holidays, the market is firm, machinery cast iron, in pieces not exceeding 1 cwt., suitable for foundry use, being stronger at 45s. to 46s., with ordinary cast-iron scrap to the same specification at 40s. per ton.

Coke.

The demand for foundry coke is very poor at the moment, and makers are prepared to enter into long-term contracts at the current rates in the endeavour to attract business. Prices remain as follow:—Best Durham coke, 36s. 6d. to 38s.; other grades, 2s. 6d. less; Welsh coke, 30s. to 45s., according to analysis, delivered Midlands.

Steel.

The markets are still somewhat unsettled after the holiday stoppage. Stocktaking operations also are holding up business, and few transactions of importance have been reported. The British works are starting the New Year in a much better position as regards the orders on their books than for many years past, but the recent fall in the prices of Continental steel threatens a revival of Continental competition in the home market. For many weeks now the British market has been almost closed to foreign sellers owing to the advance in prices in the autumn and the depreciation of sterling exchange. The demand for semi-finished steel has been quiet, and transactions relate principally to small lots for near delivery. British consumers, however, seem to be placing practically all their requirements with the home makers. In the finished-steel department export business has been quiet, but of late has shown signs of becoming more active, and when the seasonal hindrances to fresh buying have been removed the home demand will probably improve.

Metals.

Copper.—The market has not started the New Year on a very strong note. Many works have yet to buy their supplies for the next month or two, preferring to cover their immediate needs by eking out their already small stocks. This policy of hand-to-mouth consumption is probably giving the market a gloomier aspect than is really justified. There was, however, a recent rally in buying from the Continent, which served to dispose of the small cheap lots on offer, and the bigger producers increased their rates to about 5.12½ cents c.i.f. Europe. The market is still weighed down by the uncertainty arising from the failure of the producers to agree on any output-control scheme for the current year.

Closing quotations :—

Cash.—Thursday, £28 17s. 6d. to £28 18s. 9d.; Friday, £28 12s. 6d. to £28 15s.; Tuesday, £28 16s. 3d. to £28 17s. 6d.; Wednesday, £28 1s. 3d. to £28 2s. 6d.

Three Months.—Thursday, £29 5s. to £29 6s. 3d.; Friday, £28 18s. 9d. to £29 1s. 3d.; Tuesday, £29 3s. 9d. to £29 5s.; Wednesday, £28 8s. 9d. to £28 10s.

Tin.—At the moment the demand from consumers, both in this country and abroad, remains limited. Trading has been poor on the London market, and quotations have shown great weakness lately. It is felt, however, that any increase in the industrial demand would be quickly reflected in stiffened quotations.

Official closing prices :—

Cash.—Thursday, £149 2s. 6d. to £149 5s.; Friday, £149 to £149 5s.; Tuesday, £147 17s. 6d. to £148; Wednesday, £141 to £141 5s.

Three Months. — Thursday, £150 5s. to £150 7s. 6d.; Friday, £149 to £149 5s.; Tuesday, £147 17s. 6d. to £148; Wednesday, £142 to £142 5s.

Spelter.—There are indications of an increase in demand, particularly on the Continent, although consumption has fallen away lately, owing to the seasonal lull in activities at users' works. The producers' organisation continues to exercise a strict control over output; indeed, one or two cases are reported where low-cost mines could sell more metal than they are allowed to turn out.

Daily fluctuations :—

Ordinary.—Thursday, £15 6s. 3d.; Friday, £15; Tuesday, £14 18s. 9d.; Wednesday, £14 8s. 9d.

Lead.—This metal is in a far from strong position at the moment, and there is little immediate prospect of any increase in price. Unsold stocks have reached a very heavy total, and it is questioned whether the producers will not take steps to make a reduction in the present output.

The week's prices have been :—

Soft Foreign (Prompt).—Thursday, £10 15s.; Friday, £11; Tuesday, £10 13s. 9d.; Wednesday, £10 7s. 6d.

The Practical Application of Soda Ash.

(*Concluded from page* 11.)

Most cupolas are lined with siliceous materials such as ganister, Gornal stone, and the proprietary mixtures, and these may be more or less resistant to the action of soda ash than the firebrick lining, depending on the quality of the firebrick and the daubing material, but, generally speaking, most firebricks used for cupola purposes must have an alumina content greater than 33 per cent. if they are to be as resistant as the siliceous material.

Mr. Evans states that the joints between the firebricks in cupola and ladles should be as thin as possible, and this point should be emphasised. Soda-ash slags are very fluid, and therefore searching, and since the joints are the weak points in any lining where the slag could most easily penetrate and begin the work of destruction, these joints should be as thin as possible and made of suitable material. The use of cupola blocks instead of the ordinary small bricks may be helpful in this direction.

Power of Advertising.

After 10 years' absence, the Frodair Iron & Steel Company, Limited, have again returned to our advertising pages. We regard it as a token of appreciation of the value of the JOURNAL as an advertising medium, as a firm established nearly twenty years before the appearance of the JOURNAL in 1902 should have recourse to it. The truth is, of course, and we wish that it were more widely appreciated, that bad times constitute no valid excuse for any slacking off in efforts to obtain more business.

There will be few, if any, amongst our readers operating ironfoundries who have not had experience of this firm's brands of British pig-irons, especially when anxious to avoid risk in the quality of their special castings.

THE REPORT of the Forges et Acieries de la Marine et d'Homecourt states that the production of pig-iron at the Homecourt works in 1931 amounted to 276,147 tons, and that of steel to 277,347 tons. Combining the output at Homecourt with that at Micheville, the result is a total steel output of 540,613 tons. The Homecourt iron-ore mine raised 1,010,000 tons of ore, or 200,000 tons less than in the previous year. The Saint-Marcel works at Hautmont produced 58,155 tons of rolled-steel products.

SUPERIOR SILICA BRICKS
FINE SILICA CEMENT.
TRADE MARK—R. DINAS.
SMARTS DINAS SILICA BRICK CO. LTD., KIDWELLY

Grain Chill and Steel ROLLS, HEAVY CASTINGS.
IRON up to 100 Tons. *Special Air Furnace.*
STEEL up to 40 Tons. *Siemens' Steel Only.*
R. B. TENNENT, Limited, COATBRIDGE, N.B.

A Happier New Year to all Ironfounders

by using

FRODAIR PIG IRON

Best after test

Loco
Diesel
Motor
Hydraulic } **Cylinders.**

Highest in Quality.

Super-Duty Castings.

Lowest in Cost.

The
FRODAIR IRON & STEEL CO., LTD.

WEEKLY PRICE CURRENT.

COPPER.

	£	s.	d.
Standard cash	28	1	3
Three months	28	8	9
Electrolytic	33	5	0
Tough	31	0	0
Best selected	31	10	0
Sheets	61	0	0
India	42	0	0
Wire bars	34	10	0
Do., Feb.	34	15	0
Do., March	35	0	0
Ingot bars	34	10	0
H.C. wire rods	37	0	0
Off. av. cash, December	29	2	7½
Do., 3 mths., December	29	9	7¾
Do., Sttlmnt., December	29	2	4½
Do., Electro, December	34	12	2¼
Do., B.S., December	32	3	7½
Do., wire bars, December	34	17	6
Solid drawn tubes			9½d.
Brazed tubes			9½d.
Wire			6½d.

BRASS.

Solid drawn tubes	8¾d.
Brazed tubes	10¾d.
Rods, drawn	7¾d.
Rods, extd. or rlld.	4¾d.
Sheets to 10 w.g.	7¾d.
Wire	7¾d.
Rolled metal	7d.
Yellow metal rods	4¼d.
Do. 4 × 4 Squares	5¼d.
Do. 4 × 3 Sheets	5¼d.

TIN.

	£	s.	d.
Standard cash	141	0	0
Three months	142	0	0
English	141	15	0
Bars	151	10	0
Straits	153	2	6
Australian	151	7	6
Eastern	154	2	6
Banca	153	17	6
Off. av. cash, December	149	17	9¾
Do., 3 mths., December	151	1	0¾
Do., Sttlmt., December	149	18	6

SPELTER.

	£	s.	d.
Ordinary	14	8	9
Remelted	14	15	0
Hard	13	0	0
Electro 99.9	17	0	0
English	15	17	6
India	14	5	0
Zinc dust	22	0	0
Zinc ashes	2	15	0
Off. aver., December	15	5	6¾
Aver. spot, December	15	4	2¼

LEAD.

	£	s.	d.
Soft foreign ppt.	10	7	6
Empire	10	12	9
English	12	0	0
Off. average, December	11	6	10½
Average spot, December	12	2	10½

ZINC SHEETS, &c.

	£	s.	d.
Zinc sheets, English	24	10	0
Do., V.M. ex-whse.	24	5	0
Rods	27	0	0
Boiler plates	23	0	0
Battery plates		—	

ANTIMONY.

	£	s.	d.		£	s.	d.
English	37	10	0	to	42	10	0
Chinese					27	5	0
Crude					19	10	0

QUICKSILVER.

	£	s.	d.
Quicksilver	10	10	0

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro-silicon—	
25%	£8 0 0
45/50%	£13 15 0
75%	£19 10 0
Ferro-vanadium—	
35/50%	12/8 lb. Va.
Ferro-molybdenum—	
70/75% carbon-free of Mo.	6/3 per lb.
Ferro-titanium—	
23/25% carbon-free	10d. lb.
Ferro-phosphorus, 20/25%	£18 7 6
Ferro-tungsten—	
80/85%	1/7½ lb.
Tungsten metal powder—	
98/99%	1/10½ lb.
Ferro-chrome—	
2/4% car.	£32 10 0
4/6% car.	£25 0 0
6/8% car.	£24 17 6
8/10% car.	£23 10 0
Ferro-chrome—	
Max. 2% car.	£36 0 0
Max. 1% car.	£40 2 6
Max. 0.70% car.	£43 12 6
70% carbon-free	1/- lb.
Nickel—99.5/100%	£250 to £255
"F" nickel shot	£225 0 0
Ferro-cobalt	7/3 lb.
Aluminium 98/99%	£100 0 0
Metallic chromium—	
96/98%	2/9 lb.
Ferro-manganese (net)—	
76/80% loose	£10 15 0 to £11 5 0
76/80% packed	£11 15 0 to £12 5 0
76/80% export	(nom.) £9 15 0
Metallic manganese—	
94/96% carbon-free	1/4 lb.

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten	2s. 0d.
Finished bars, 18% tungsten	2s. 9d.

Per lb. net, d/d buyers' works.

Extras—	
Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under ¼ in. to ⅛ in.	3d. lb.
Do., under ⅛ in. to $\frac{5}{16}$ in.	1/- lb.
Flats, ½ in. × ⅛ in. to under 1 in. × ⅛ in.	3d. lb.
Do., under ½ in. × ⅛ in.	1/- lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra.

SCRAP.

	£	s.	d.		£	s.	d.
South Wales—							
Heavy steel					2	0	0
Bundled steel and shrngs.	1	15	0	to	1	17	6
Mixed iron and steel	1	14	0	to	1	16	6
Heavy cast iron					2	2	6
Good machinery					2	7	6
Cleveland—							
Heavy steel					2	0	0
Steel turnings					1	12	6
Cast-iron borings					1	3	6
Heavy forge					2	10	0
W.I. piling scrap					2	2	6
Cast-iron scrap	1	18	6	to	2	2	0
Midlands—							
Light cast-iron scrap					1	16	0
Heavy wrought iron					2	5	0
Steel turnings, f.o.r.					1	0	6
Scotland—							
Heavy steel	1	15	0	to	1	17	6
Ordinary cast iron					2	0	0
Engineers' turnings					1	10	0
Cast-iron borings					1	10	6
Wrought-iron piling					1	19	0
Heavy machinery					2	5	6

London—Merchants' buying prices delivered yard.

	£	s.	d.		£	s.	d.
Copper (clean)					21	0	0
Brass					14	0	0
Lead (less usual draft)					10	0	0
Tea lead					8	10	0
Zinc					8	10	0
New aluminium cuttings					72	0	0
Braziery copper					19	0	0
Gunmetal					18	0	0
Hollow pewter					80	0	0
Shaped black pewter					60	0	0

PIG-IRON.

(f.o.t. unless otherwise stated.)

N.E. Coast—	
Foundry No. 1	61/-
Foundry No. 3	58/6
„ at Falkirk	54/-
Foundry No. 4	57/6
Forge No. 4	57/-
Hematite No. 1	59/6
Hematite M/Nos.	59/-
N.W. Coast—	
Hem. M/Nos. d/d Glas.	69/-
„ d/d Birm.	84/6
Malleable iron d/d Birm.	117/6
Midlands (d/d Birmingham dist.)—	
Staffs No. 4 forge	61/-
„ No. 3 fdry.	66/-
Northants forge	57/6
„ fdry. No. 3	62/6
„ fdry. No. 1	65/6
Derbyshire forge	61/-
„ fdry. No. 3	66/-
„ fdry. No. 1	69/-
„ basic	—
Scotland—	
Foundry No. 1	70/-
„ No. 3	67/6
Hem. M/Nos. d/d	66/-
Sheffield (d/d district)—	
Derby forge	58/6
„ fdry. No. 3	63/6
Lincs forge	—
„ fdry. No. 3	63/6
E.C. hematite	73/6
W.C. hematite	83/6
Lancashire (d/d eq. Man.)—	
Derby forge	62/-
„ fdry. No. 3	67/-
Staffs fdry. No. 3	67/-
Northants fdry. No. 3	65/6
Cleveland fdry. No. 3	67/-
Dalzell, No. 3 (special)	102/6 to 105/-
Glengarnock, No. 3	82/6
Clyde, No. 3	82/6
Monkland, No. 3	82/6
Summerlee, No. 3	82/6
Eglinton, No. 3	82/6
Gartsherrie, No. 3	82/6
Shotts, No. 3	82/6

FINISHED IRON AND STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

	£	s.	d.		£	s.	d.
Iron—							
Bars (cr.)	9	0	0	to	9	15	0
Nut and bolt iron	7	15	0	to	8	0	0
Hoops	10	10	0	to	12	0	0
Marked bars (Staffs) f.o.t.					12	0	0
Gas strip	10	10	0	to	12	0	0
Bolts and nuts, ¾ in. × 4 in.					13	0	0
Steel—							
Plates, ship, etc.	8	15	0	to	8	17	6
Boiler plts.	8	7	6	to	9	5	0
Chequer plts.					10	7	6
Angles					8	7	6
Tees					9	7	6
Joists					8	15	0
Rounds and squares, 3 in. to 5½ in.					9	7	6
Rounds under 3 in. to ¾ in. (Untested)					6	15	0 & up.
Flats—8 in. wide and over					8	12	6
„ under 8 in. and over 5 in.					8	17	6
Rails, heavy	8	5	0	to	8	10	0
Fishplates					12	0	0
Hoops (Staffs)	9	10	6	to	10	10	0
Black sheets, 24g. (10-t. lots)					9	10	0
Galv. cor. shts.					11	15	0
Galv. flat shts. „					12	5	0
Galv. fencing wire, 8g. plain					14	0	0
Billets, soft	4	17	6	to	5	7	6
Billets, hard	6	12	6	to	7	2	6
Sheet bars	4	15	0	to	5	2	6
Tin bars					4	15	0

PHOSPHOR BRONZE.

	Per lb. basis.
Strip	10½d.
Sheet to 10 w.g.	11½d.
Wire	11⅜d.
Rods	10½d.
Tubes	16d.
Castings	12½d.

Delivery 3 cwt. free.
10% phos. cop. £30 above B.S.
15% phos. cop. £35 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. CLIFFORD & SON, LIMITED.

NICKEL SILVER, &c.

	Per lb.
Ingots for raising	7d. to 1/1
Rolled—	
To 9 in. wide	1/1 to 1/7
To 12 in. wide	1/1½ to 1/7½
To 15 in. wide	1/1½ to 1/7½
To 18 in. wide	1/2 to 1/8
To 21 in. wide	1/2½ to 1/8½
To 25 in. wide	1/3 to 1/9
Ingots for spoons and forks	7d. to 1/3½
Ingots rolled to spoon size	10d. to 1/6½
Wire round—	
to 10g.	1/4½ to 1/11½

with extras according to gauge.
Special 5ths quality turning rods in straight lengths, 1/3½ upwards.

AMERICAN IRON AND STEEL.

At Pittsburgh unless otherwise stated.

	Dols.
No. 2 foundry, Phila.	13.34
No. 2 foundry, Valley	14.50
No. 2 foundry, Birm.	11.00
Basic	15.39
Bessemer	16.89
Malleable	16.39
Grey forge	16.39
Ferro-mang. 80%, seaboard	68.00
O.-h. rails, h'y, at mill	40.00
Billets	26.00
Sheet bars	26.00
Wire rods	37.00
	Cents.
Iron bars, Phila.	1.86
Steel bars	1.60
Tank plates	1.60
Beams, etc.	1.60
Skelp, grooved steel	1.60
Steel hoops	1.55
Sheets, black, No. 24	2.10
Sheets, galv., No. 24	2.85
Wire nails	1.95
Plain wire	2.20
Barbed wire, galv.	2.60
Tinplates, 100-lb. box	$4.75

COKE (at ovens).

Welsh foundry	20/- to 22/6
„ furnace	16/- to 16/6
Durham and Northumberland—	
„ foundry	21/- to 25/-
„ furnace	13/6
Midlands, foundry	—
„ furnace	—

TINPLATES.

f.o.b. Bristol Channel ports.

I.C. cokes 20×14 per box	16/-
„ 28×20 „	32/-
„ 20×10 „	23/-
„ 18¾×14 „	16/7½
C.W. 20×14 „	14/-
„ 28×20 „	29/3 to 29/6
„ 20×10 „	19/10
„ 18¾×14 „	14/-

SWEDISH CHARCOAL IRON & STEEL.

Pig-iron	£6	0	0	to	£7	0	0
Bars-hammered, basis	£16	10	0	to	£17	0	0
Bars and nail-rods, rolled, basis	£15	17	6	to	£16	5	0
Blooms	£10	0	0	to	£12	0	0
Keg steel	£32	0	0	to	£33	0	0
Faggot steel	£18	0	0	to	£23	0	0
Bars and rods dead soft, st'l	£10	0	0	to	£12	0	0

All per English ton, f.o.b. Gothenburg.
[Subject to an exchange basis of Kr. 18.16 to £1.]

DAILY FLUCTUATIONS.

Standard Copper (cash).

		£	s.	d.	
Dec.	29 ..	28	17	6	inc. 7/6
,,	30 ..	28	12	6	dec. 5/-
Jan.	3 ..	28	16	3	inc. 3/9
,,	4 ..	28	1	3	dec. 15/-

Standard Tin (cash).

		£	s.	d.	
Dec.	29 ..	149	2	6	inc. 15/-
,,	30 ..	149	0	0	dec. 2/6
Jan.	3 ..	147	17	6	,, 22/6
,,	4 ..	141	0	0	,, 137/6

Spelter (ordinary).

		£	s.	d.	
Dec.	29 ..	15	6	3	dec. 2/6
,,	30 ..	15	0	0	,, 6/3
Jan.	3 ..	14	18	9	,, 1/3
,,	4 ..	14	8	9	,, 10/-

Zinc Sheets (English).

		£	s.	d.	
Dec.	29 ..	24	10	0	No change
,,	30 ..	24	10	0	,, ,,
Jan.	3 ..	24	10	0	,, ,,
,,	4 ..	24	10	0	,, ,,

Electrolytic Copper.

		£	s.	d.	
Dec.	29 ..	34	7	6	inc. 12/6
,,	30 ..	34	5	0	dec. 2/6
Jan.	3 ..	34	0	0	,, 5/-
,,	4 ..	33	5	0	,, 15/-

Tin (English ingots).

		£	s.	d.	
Dec.	29 ..	149	15	0	inc. 15/-
,,	30 ..	149	15	0	No change
Jan.	3 ..	148	10	0	dec. 25/-
,,	4 ..	141	15	0	,, 135/-

Spelter (Electro, 99.9 per cent.).

		£	s.	d.	
Dec.	29 ..	17	15	0	No change
,,	30 ..	17	10	0	dec. 5/-
Jan.	3 ..	17	10	0	No change
,,	4 ..	17	0	0	dec. 10/-

Lead (English).

		£	s.	d.	
Dec.	29 ..	12	5	0	No change
,,	30 ..	12	10	0	inc. 5/-
Jan.	3 ..	12	5	0	dec. 5/-
,,	4 ..	12	0	0	,, 5/-

AVERAGE MONTHLY PRICES OF UNMARKED BARS (SOUTH STAFFS).

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly average
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1898	6 0 0	6 0 0	6 0 0	6 0 0	6 0 0	6 0 0	6 0 0	6 5 0	6 5 0	6 5 0	6 10 0	6 10 0	6 2 11
1899	6 10 0	6 15 0	6 15 0	6 15 0	7 0 0	7 0 0	7 10 0	7 10 0	8 10 0	9 0 0	9 0 0	9 10 0	7 12 11
1900	10 0 0	10 10 0	10 10 0	10 10 0	10 15 0	10 15 0	10 5 0	10 5 0	10 5 0	9 10 0	8 15 0	8 15 0	10 1 8
1901	8 0 0	7 10 0	7 5 0	7 0 0	6 10 0	6 10 0	6 10 0	6 10 0	6 15 0	6 15 0	6 15 0	6 15 0	6 17 11
1902	7 0 0	6 10 0	6 15 0	6 15 0	6 15 0	6 10 0	6 10 0	6 15 0	6 15 0	6 15 0	6 10 0	6 10 0	6 13 4
1903	6 10 0	6 10 0	6 10 0	6 10 0	6 10 0	6 10 0	6 10 0	6 10 0	6 10 0	6 10 0	6 7 0	6 5 0	6 9 4
1904	6 5 0	6 5 0	6 5 0	6 5 0	6 10 0	6 5 0	6 0 0	6 0 0	6 0 0	6 0 0	6 0 0	6 0 0	6 2 11
1905	6 5 0	6 5 0	6 0 0	5 17 6	5 15 0	5 15 0	5 15 0	5 15 0	6 0 0	6 5 0	6 15 0	6 15 0	6 1 10½
1906	7 0 0	7 5 0	7 5 0	7 5 0	6 17 6	6 15 0	6 12 6	6 10 0	6 10 0	6 12 6	6 16 3	7 3 9	6 17 8½
1907	7 3 9	7 5 0	7 5 0	7 5 0	7 5 0	7 7 6	7 5 0	7 7 6	7 7 6	7 7 6	7 7 6	7 5 0	7 5 11
1908	7 2 6	7 0 0	7 0 0	7 0 0	6 15 0	6 7 6	6 5 0	6 2 6	6 2 6	6 2 6	6 2 6	6 0 0	6 10 0
1909	6 0 0	6 0 0	6 0 0	5 17 6	6 0 0	6 0 0	6 0 0	5 17 6	6 0 0	6 2 6	6 2 6	5 17 6	5 19 9½
1910	6 2 6	6 3 4½	6 7 6	6 7 6	6 7 6	6 7 6	6 6 6	6 5 0	6 5 0	6 5 0	6 5 0	6 5 0	6 5 7
1911	6 5 0	6 5 0	6 5 0	6 5 0	6 5 0	6 5 0	6 5 0	6 5 0	6 5 0	6 10 0	6 12 6	6 16 6	6 7 0
1912	6 18 9	7 1 10	7 2 6	7 8 9	7 18 0	8 0 7	8 2 6	8 3 6	8 5 0	8 6 3	8 7 6	8 8 9	7 17 0
1913	8 11 6	8 10 7½	8 10 0	8 8 1½	8 2 0	8 0 0	7 17 6	7 11 6	7 8 9	7 5 6	6 18 1½	6 17 6	7 16 9
1914	6 17 6	6 15 7½	6 12 6	6 10 0	6 10 0	6 10 0	6 10 0	7 11 10½	8 0 0	7 12 6	7 5 7½	7 6 3	7 1 0
1915	7 11 6	8 5 11	8 8 9	9 6 0	10 3 2	10 19 2	11 12 6	11 13 1½	11 13 9	11 14 3	12 1 10½	13 0 9	10 6 0
1916	13 7 6	13 10 8	13 12 9½	13 15 0	13 15 0	13 15 0	13 15 0	13 15 0	13 15 0	13 15 0	13 15 0	13 15 0	13 3 9½
1917	13 15 0	13 15 0	13 15 0	13 15 0	13 15 0	13 15 0	13 15 0	13 15 0	13 15 0	13 15 0	13 15 0	13 15 0	13 15 0
1918	13 15 0	13 17 3	13 17 6	13 17 6	13 17 6	13 17 6	13 17 6	14 15 0	14 15 0	14 15 0	14 15 0	14 15 0	14 4 5½
1919	15 10 0	16 5 0	17 15 0	17 15 0	20 15 0	21 0 0	21 0 0	22 0 0	22 0 0	22 0 0	22 7 6	22 12 6	20 1 8
1920	24 7 6	24 10 0	25 10 0	27 10 0	29 5 0	31 0 0	31 10 0	31 10 0	31 10 0	31 10 0	31 10 0	29 7 6	29 1 8
1921	26 17 3	25 0 0	23 0 0	21 0 0	19 0 0	18 5 0	16 0 0	16 0 0	15 14 0	14 0 0	13 6 8	13 0 0	19 4 5
1922	13 0 0	12 3 9	11 14 0	11 11 10½	11 5 0	11 3 6	11 2 6	11 5 0	10 17 2½	10 16 3	10 13 0	10 12 6	11 7 0½
1923	10 16 10½	11 3 1½	12 2 6	12 8 9	12 11 6	12 1 3	11 15 11½	11 15 0	11 15 0	11 15 0	12 13 6	12 8 3	11 18 10½
1924	12 9 6	12 10 0	12 10 0	12 15 7½	12 17 6	12 17 6	12 17 6	12 17 6	12 17 6	12 14 0	12 12 6	12 12 6	12 14 3½
1925	12 12 6	12 12 6	12 12 6	12 12 6	12 12 6	12 7 6	12 7 6	12 7 6	12 4 6	11 18 6	11 13 6	11 13 0	12 6 2½
1926	11 7 9½	11 5 0	11 5 0	11 5 0	11 3 9	11 3 9	11 5 0	12 0 0	13 0 0	*	15 7 6	12 19 0	12 0 2
1927	12 6 3	12 2 6	11 14 0	11 0 0	10 18 9	10 13 6	10 12 6	10 5 0	9 16 0	9 15 0	9 13 9	9 12 9	10 14 2
1928	9 12 6	9 12 6	9 11 0	9 10 0	9 8 4	9 5 0	9 5 0	9 5 0	9 5 0	9 5 0	9 3 6	9 1 3	9 7 0
1929	9 0 0	9 2 6	9 5 7½	9 9 4½	9 10 0	9 17 6	10 2 6	10 2 6	10 2 6	10 0 6	10 3 9	10 5 7	9 15 2½
1930	10 7 6	10 7 6	10 7 6	10 6 10½	10 6 3	10 5 6	10 2 6	10 2 6	10 2 6	10 2 6	10 2 6	10 2 6	10 4 7½
1931	10 2 6	10 0 0	10 0 0	10 0 0	9 18 1½	9 17 6	9 17 6	9 17 6	9 17 6	9 17 6	9 17 6	9 16 10½	9 18 0½
1932	9 15 0	9 15 0	9 15 0	9 15 0	9 13 9	9 11 3	9 10 0	9 10 0	9 10 0	9 6 3	9 5 0	9 5 0	9 10 11½

* No quotation available owing to strike.

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NOTICE IS HEREBY GIVEN that Tenders for Goods and Services of the kinds mentioned below are invited from time to time as required :—

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Baths, Bicycles, Building Materials and Fitments, Cutlery (including Safety Razors and Blades), Enamelled-ware, Hollow-ware, Horseshoes, Ironmongery, Machinery, Reinforcing Metal, Stable Fitments, Steel and Cast-iron Pipes, Steel Shuttering for Concrete Work, Stoves and Ovens, Tinware (including Canisters, etc., to precise dimensions), Tools, Tubular Scaffolding, Vehicles, Wire, Wire Rope.

ELECTRICAL AND SCIENTIFIC INSTRUMENT TRADES.

Cables, Electrical Plant, Electrical and Wireless Stores, Scientific Instruments.

Continued in next Column.

TENDER—*Continued.*

Continued from previous Column.

TEXTILE TRADES.

Blankets and Rugs, Braid and Lace, Canvas and Canvas Goods, Clothing (made up from the Department's own materials), Cotton Piece Goods and Cotton Goods, Cordage, Flannel (Union), Head-dresses, Horse Rugs, Hosiery, Linen Piece Goods, Silk Cloth and Webbing and Sewing Silk, Towels, Woollen Cloths.

FOODSTUFFS, COAL AND COKE. OTHER TRADES.

Badges and Buttons, Basket-ware, Bedding, Boots and Shoes, Brooms and Brushes, Chemicals and Oxygen and Acetylene Gas, China and Earthenware, Furniture, Glazed-ware Drain Pipes, Harness and Saddlery, Leather and Leather Goods, Linoleum, Medical Supplies, Moulded Rubber Articles, Oil-dressed Clothing, Oils and Spirits, Paints and Varnishes, Rubber Boots and Clothing, Safety Glass, Sanitary Appliances, Timber, Woodware.

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Jobbing, Painting and Repair Work (including Term Contracts), New Buildings, Heating and Electrical Installations, Erection of Constructional Steelwork, Reinforced-concrete Work, Road and Drainage Work, Roofing and Flooring Work, Construction of Sports Grounds, etc.

Firms who are not already on the War Office List of Tenderers, and who wish to be invited to tender for the above Army requirements, should apply in writing to the Director of Army Contracts, Caxton House (West), Tothill Street, Westminster, London, S.W.1, for Form 1 (Form 1A in respect of the services mentioned under Building Works above), on which formal application for inclusion on the list of tenderers may be made. The services of an intermediary are unnecessary in approaching the Department for this purpose.

Before being placed on the lists of tenderers, firms will have to satisfy the Department that they actually manufacture goods or carry out services for which they wish to be noted, and will be required to furnish the names of at least two well-known firms or public bodies who have employed or purchased from them and are in a position to certify as to the quality of their work. They will further have to give an undertaking that they will comply with the Fair Wages Resolution of the House of Commons.

Attention is called to the following resolution passed by both Houses of Parliament on February 16, 1926 :—

"That, in the opinion of this House, it is the duty of the Government in all Government contracts to make provision for the employment to the fullest possible extent of disabled ex-Service men, and to this end to confine such contracts, save in exceptional circumstances, to employers enrolled on the King's National Roll."

SALES.

From time to time the Department has for sale surplus Army stores of various descriptions, among which may be mentioned Machinery, Scrap Metals, Hutting, Motor Vehicles and Spare Parts, Medical and Dental Stores, Veterinary Stores, Optical and Scientific Instruments, Electrical and Wireless Stores, Clothing, Boots, Textile Goods, Explosives and Chemicals (including Drugs, Ammonium Nitrate, Sodium Picrate and Cordite).

Firms who wish to be invited to tender for the purchase of surplus stores should apply in writing to the Director of Army Contracts, Caxton House (West), Tothill Street, Westminster, London, S.W.1.

Sales of surplus stores by auction are also held at the Royal Arsenal, Woolwich, about the middle of January, March, May, July, September and November. Catalogues may be obtained from the Chief Ordnance Officer, Royal Arsenal, Woolwich, S.E.18.

No application is necessary from firms whose names are already on the War Office lists, unless they have extended the range of their manufactures.

F. C. BOVENSCHEN,
Director of Army Contracts.

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